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the rationale for health professionals

Alberta

A GUIDE TO INFANT NUTRITION -
the rationale for health professionals

Revised Edition
March 1983/6M

This is a revision of the manual "A Guide To Infant Nutrition - the rationale for health professionals" printed in 1981. The information provided summarizes the findings from recognized research and reflects current approved practices in infant nutrition which, if followed, will result in the best choices for infants.

The manual is intended to be a ready reference for health professionals who provide nutrition counselling to the parents of healthy infants. Its use will facilitate delivery of a congruent message.

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PREFACE

The overall philosophy and recommendations in this manual have not changed substantially from the previous edition (December, 1980). Most of the recommendations are reaffirmed. The benefits of breast milk and the delayed introduction of solids and cow milk continue to be emphasized.

The feeding pattern presented in this manual is summarized below.

SUGGESTED INFANT FEEDING PATTERN

FOOD	AGE IN MONTHS											
Recommended XX Optional 00	1	2	3	4	5	6	7	8	9	10	11	12
Breast Milk or Formula*	XX	XX	XX	XX	XX	XX	00	00	00	00	00	00
Unsweetened Juice (vitamized, if non-citrus)			00	00	00	XX	XX	XX	XX	XX	XX	XX
Solids**												
Cereals			00	00	00	XX	XX	XX	XX	XX	XX	XX
Vegetables			00	00	00	XX	XX	XX	XX	XX	XX	XX
Fruits			00	00	00	XX	XX	XX	XX	XX	XX	XX
Meat or Alternatives						XX	XX	XX	XX	XX	XX	XX
Egg Yolk, Cooked						XX	XX	XX	XX	XX	XX	XX
Whole Egg, Cooked								00	00	00	00	00

*Proprietary formulas are nutritionally superior to other formulas.
**Texture progresses from puree, to minced, to family foods.

NOTE: Whole, partially skimmed (2%) and skim milks are contraindicated for infants.

1. PROMOTING GOOD FOOD HABITS

Health professionals have the opportunity to exert an influence on the development and promotion of good food habits in the young child. Ideally, they use every teaching situation with the parents to provide accurate information about feeding practices and nutrient requirements. Parents should know that to a large extend the child's attitudes about food and eating are acquired during the first five years of life, and that these attitudes are based on a combination of cultural, economic, familial, and environmental factors. Most of these are developed subconsciously on the part of the child as learner and the family as teacher. Parents' attitudes towards foods, feeding practices and eating patterns all influence how an infant relates to food. It should be remembered that the parent determines either directly or indirectly, the type, amount and seasoning of food eaten by the infant. Ideally, parents respond to their child's food related cues promptly and appropriately.

The health worker's role involves helping the parents assess their beliefs and values regarding food, nutrition and growth. As well, the parents should be encouraged to adopt and promote good food habits. Counselling and encouragement throughout the child's growth and maturation are necessary.

Parents may need guidance to realize that for the infant and toddler, food provides more than nourishment. Food may represent security and love; it may be a vehicle to express frustration or anger; it may be a means of getting attention. Parents should be aware that these behaviours, in moderation, reflect the normal development of the child.

During infancy a variety of hunger and satiety indicators are developed; these are continued in early childhood, expanding as physical and social skills mature. The health professional should remind parents that physical maturation is progressive and predictable. For example, until four months of age most babies will push food out when it is placed near the tip of the tongue. After six months, maturing of the digestive

system increases the ability to accept a variety of foods and by seven months chewing has usually been learned.

At one year of age the infant is incapable of controlling hand and arm movements sufficiently well to move the spoon smoothly from hand to mouth. The toddler is a messy eater, ritualistic, and has an erratic appetite. As his diet expands to include solids or table foods, he discovers new textures and flavours. At the same time he is gaining awareness of his power to accept or reject what is offered. Babies will show a variety of responses to new foods, accepting some more readily than others.

2. BREAST FEEDING

2.1 Advantages of Breast Feeding

The benefits of breast feeding are discussed under six general headings.

1. Psychological
2. Safety
3. Immunological
4. Economical
5. Physiological
6. Nutritional

2.1.1 Psychological Benefits

By its very nature, breast feeding requires close skin to skin contact which is a stimulator of a strong maternal-infant bond. When an infant is bottle-fed such attachment may require a conscious effort on the part of the mother. The benefits of a close maternal-infant bond are real and actively contribute to the optimum health and development of the child.

2.1.2 Safety

Breast feeding does not introduce outside contamination. Breast milk requires no preparation so the danger of the infant receiving an incorrectly prepared formula, i.e. overconcentrated or overdiluted, is eliminated.

2.1.3 Immunological Benefits

Human milk is the only milk which provides specific immunological benefit to the human infant. This may be partially responsible for the observation that breastfed

infants have fewer serious respiratory and gastrointestinal illnesses in comparison to bottle-fed infants in a similar environment.

Colostrum and mature human milk both contain compounds of immunological benefit to the baby. They contain immunologlobulins IgG, IgM and most importantly, IgA - all of which enhance the infant's defense mechanisms.

IgA is unique in that it resists protein digestion. Its role is to confer passive mucosal immunity in the gastrointestinal tract against such organisms as E. coli. IgA is present in large amounts in colostrum and smaller amounts in mature breast milk.

Human milk also contains lysosomes, leukocytes, and lactoferrin. Lysosomes are enzymes necessary for the destruction of bacteria. They do this by rupturing the cell wall of many bacteria. Leukocytes are comprised of phagocytes and lymphocytes. The latter are responsible for antibody production (i.e. IgA) and for cellular immune responses. Lactoferrin is an iron binding protein present in high concentrations in breast milk. It prevents iron from occurring in a free state within the gut, therefore depriving bacteria, such as E. coli, which require this mineral for their growth. With the presence of large amounts of iron in the infant's diet, the lactoferrin would become saturated and free iron would be available in the gut for use by bacteria. Thus, the low iron content of breast milk may protect the infant from gastrointestinal illnesses.

Research indicates human milk contains the "bifidus factor". This is a group of nitrogen containing polysaccharides which are acted on by the lactobacillus flora present in the gut. The resultant lower pH promotes the

growth of the organism, lactobacillus bifidus, thereby minimizing the colonization of the gut by other, more pathogenic flora. The "bifidus factor" is not present in appreciable amounts in cow milk.

Breast feeding reduces or eliminates the use of formulas containing foreign protein. This spares the gut from exposure to food antigens at a time when these are readily absorbed and may cause local or systemic immune reactions. Thus, feeding of human milk reduces the possibility of the development of some allergies such as those to cow milk protein. The common manifestations of allergy in infancy, i.e. diarrhea, eczema, atopic dermatitis, rhinitis, and wheezing are much less common in breastfed than in formula fed infants.

2.1.4 Economical Benefits

Breast feeding by itself may or may not be more economical than bottle feeding. The mother requires extra food to meet her needs for milk production. The total cost of her diet, depending on her food purchasing practices and selection of foods, will be reflected in the "cost" of breast milk. In terms of the medical and hospital costs related to the higher morbidity associated with the use of formula, breast feeding is more economical.

2.1.5 Physiological Benefits

Physiologically, breast feeding is beneficial for the mother in a number of ways. During pregnancy the mother gains extra body fat which acts as an energy reserve. After delivery this is used to meet some of the mother's extra energy needs for milk production. Over a period of three to six months of breast feeding this fat is lost and the mother generally returns to her pre-pregnancy weight.

Secondly, the act of breast feeding stimulates the release of oxytocin which helps to contract the uterus promoting involution. Breast feeding also acts to inhibit ovulation; however, it is not a reliable form of contraception.

2.1.6 Nutritional Benefits

Breast milk provides the infant from birth to six months with virtually all the nutrients he needs for normal growth. The amount of each is sufficient for his needs without being excessive. The more complete utilization of the nutrients in breast milk, and their presence in the right combinations, results in fewer gastrointestinal disturbances, including constipation and diarrhea, than does a proprietary (commercial) formula or cow milk.

When the infant is breastfed, it is the infant who decides how much will be taken at a feeding. The infant "eats to his appetite", whereas with bottle feeding there is the possibility that the parent will persist until the bottle is empty. This tendency may be a factor in the genesis of infantile obesity.

2.2 Composition of Breast Milk

The composition of colostrum, breast milk, undiluted whole cow milk, and proprietary formula are presented in Table 1. Colostrum is somewhat lower in energy, carbohydrate as lactose, and fat than is mature breast milk. Undiluted whole cow milk has a greater content of protein and minerals, and a lower concentration of lactose than human milk.

Proprietary formulas which simulate the nutrient composition of mature breast milk are available. The nutritional and immunological advantages which make human milk superior to these products are noted in Section 2.1. - Advantages of Breast Feeding.

Table 1

COMPARATIVE COMPOSITION OF COLOSTRUM, MILKS AND PROPRIETARY FORMULA[1]

Nutrient (per 100 mL)	Colostrum (1-5 days)	Milk		Proprietary Formula
		Human	Cow	
kJ (kcal)	251 (60)	314 (75)	276 (66)	280 (67)
Protein (g)	2.7 - 3.2	0.9 - 1.1	3.2 - 3.5	1.5 - 1.6
Fat (g)	2.5 - 2.9	4.0 - 4.5	3.5 - 3.7	3.6 - 3.7
Lactose (g)	5.0 - 5.7	6.8 - 7.2	4.9 - 5.0	7.0 - 7.3
Calcium (mg)	27 - 31	29 - 33	117 - 122	44 - 54
Phosphorous (mg)	14 - 15	14 - 15	92 - 93	33 - 46
Iron (mg)	0.09 - 0.1	0.05 - 0.03*	0.05	Trace - 1.3
Vitamin A (R.E.)	54 - 161	57 - 72	31 - 43	51 - 75
Thiamin (mg)	0.01 - 0.35	0.01 - 0.2	0.03 - 0.04	0.05 - 0.06
Riboflavin (mg)	0.01 - 0.02	0.03 - 0.04	0.01 - 0.02	0.05 - 0.10
Niacin (mg)	0.075	0.015 - 0.017	0.09 - 0.10	0.6 - 1.0
Ascorbic Acid (mg)	4.4	4.3 - 5.0	1.0 - 1.1	5.4 - 5.7
Sodium (mg)	47	15 - 16	50	22 - 25
Vitamin D (I.U.)	?	2.2	36 - 42**	40 - 43

[1] Adapted from values in:

Pipes, P.L. Nutrition in Infancy and Childhood, Second Edition, p. 140.
Worthington, B.S. et al. Nutrition in Pregnancy and Lactation, Second Edition, p. 170.
Ross Laboratories. Similac/Similac with Iron Infant Formulas, p. 5, 9, 13, 17, 23.
Mead Johnson Canada. Infant Formula Compendium.
Health and Welfare Canada. Nutrient Value of Some Common Foods, 1979.

* Median values at 2 weeks and 5 months of lactation.
** Assumes fortification with 36 I.U. per 100 mL.

2.2.1 Protein

The protein content of breast milk is ideally suited to the needs of the infant. Both human and cow milk contain the major milk proteins, casein and whey; however, breast milk has a casein-to-whey ratio of 40:60, whereas cow milk has a ratio of 82:18. The high casein content in cow milk is responsible for large, poorly digested curds in the stomach if the milk is not properly treated to reduce the curd size. In breast milk, the whey produces a more flocculent curd and thus provides for a more complete utilization of protein by the baby. This is important throughout infancy but especially in the newborn or premature infant whose enzyme systems are not able to handle cow milk protein efficiently.

The lower protein content of human milk places much less strain on the kidneys and makes it easier for the baby to maintain his water balance. The protein content of proprietary formulas is similar to that of human milk but not as well utilized. It does, however, provide for satisfactory growth. The high level of protein in unmodified cow milk exceeds nutritional requirements and places an unnecessary strain on the infant's kidneys. The effect of high protein intake is discussed in Section 4 - Water Balance and Renal Solute Load.

2.2.2 Carbohydrate

The major carbohydrate in milk is lactose. It is believed that this sugar creates an acid environment in the gut which inhibits the growth of undesirable bacteria and improves the absorption of calcium, phosphorus, magnesium and other minerals. These benefits are more significant in the breastfed than in the bottle-fed infant since human

milk contains more lactose than cow milk (approximately 7% and 4% respectively).

In the first few weeks of life, the baby's gut may not produce enough of the digestive enzyme lactase. As a result, the breastfed baby may have loose stools. This is discussed in Section 9.3 - Diarrhea - Loose Stools.

2.2.3 Fat

Fat, the common term for dietary lipids, is necessary in the infant's diet as a source of energy and for normal growth and development. The fatty acid composition of breast milk differs from that of cow milk and proprietary formulas. Breast milk and proprietary formulas both contain much more linoleic acid, an essential fatty acid.

The fatty acid pattern in breast milk varies with the mother's diet and stage of nursing. Human milk contains a higher content of unsaturated fatty acids than cow milk, but a smaller content than most proprietary formulas. Unsaturated fatty acids are more easily absorbed by infants than saturated fatty acids.

The lipids in breast milk are absorbed equally as well as those in proprietary formulas but the type of fatty acid is different. The fat in both of these types of milks is more easily digested than that in cow milk. Breast milk contains an enzyme, lipase, which promotes rapid and complete digestion of fat. In addition, the fatty acids are located on the triglyceride molecule in a manner which promotes optimum absorption and prevents the formation of insoluble soaps in the gut. Unabsorbed fatty acids and calcium combine to form these soaps and lead to impaired fat absorption and frothy stools.

Currently, proprietary formulas contain only traces of cholesterol (1.5-3.0 mg/dL), whereas breast milk contains moderate amounts (20 mg/dL). The significance of this difference is unknown.

2.2.4 Minerals

The amounts of minerals and electrolytes in breast milk and most proprietary formulas meet the needs of the baby but are not at levels which place a strain on the infant's metabolism. In whole cow milk and particularly 2% and skim milks, the concentration of electrolytes is much higher than in breast milk and proprietary formula. This excess adds to the renal solute load which must be excreted by the infant's kidneys as discussed in Section 4 - Water Balance and Renal Solute Load.

In breast milk the calcium to phosphorous ratio, 2:1, enhances the absorption of calcium. Both these minerals, as well as magnesium, are present in quantities ideal for infant growth. The sodium content of breast milk is about one third that of cow milk and approximately one half that of proprietary formulas. A low level of sodium is more compatible with an infant's immature renal system.

The iron content of breast milk is about .05 mg/100 mL, a level which appears acceptable for the growing infant. It has been demonstrated that up to 80 percent of the iron in breast milk may be absorbed by the infant. This compares with an average bioavailability of 5-10 percent for the iron in cow milk and other foods.

2.2.5 Vitamins

Breast milk contains adequate amounts of all the vitamins needed by the infant, with the possible exception of

vitamin D. Researchers have recently found that vitamin D is present in breast milk in both water and fat soluble forms. The relative amounts of these forms and utilization of vitamin D present in breast milk is still under investigation. Until verified, it is recommended that the breastfed infant be given an infant pharmaceutical product containing vitamin D.

2.3 Preparation for Breast Feeding

Most women who wish to breast feed can do so. Factors which contribute to successful breast feeding include a supportive environment, knowledge about breast feeding, a healthy mother, and a healthy baby. Preparation for breast feeding should begin early in pregnancy and continue until lactation is successfully established.

Health professionals can play an important role in promoting breast feeding. Although a natural process, the art of breast feeding must be learned by mother and baby together. There are several excellent books on breast feeding which may be recommended. Also, there is the pamphlet "Breast Feeding - It's Your Choice", which is produced by Alberta Social Services and Community Health. When counselling, the health professional may make the parents aware of the following.

1. Expectations and Feelings
2. Breast Feeding Role Models
3. Care of the Breasts
4. Physiology of Lactation
5. Establishing the Milk Supply
6. Diet During Lactation
7. Duration of Lactation

2.3.1 Expectations and Feelings

The parents need open discussion of their expectations and feelings about breast feeding before making a commitment.

Discussion should begin early in pregnancy and both parents should endorse the decision to breast feed. Inhibited lactation and a sense of parental falure may occur when belief and commitment to breast feeding are not consistent. Mothers who choose not to, or are unable to breast feed should be given support. They should be assured that bottle feeding, using appropriate formulas and feeding techniques, is a satisfactory alternative.

2.3.2 Breast Feeding Role Models

The technique of breast feeding must be learned; however, opportunities to learn may be limited. Role models are not always readily available. The members of La Leche League International, Inc. help fill the gap for those unable to find support among family or friends.

2.3.3 Care of the Breasts

As pregnancy progresses information concerning care of the breasts should be made available to the expectant mother. Examination of the breasts early in pregnancy can determine whether the nipples harden and swell or retract when stimulated between thumb and forefinger. If the nipple tends to retract, a Woolwich shield may be worn during the day in pregnancy and between feedings during lactation to promote protrusion of the nipple. These shields may be available through the La Leche League International, Inc. and in some pharmacies.

Breast exercises should also be encouraged throughout the pregnancy. These consist of nipple rolling, areola stretching, hand expression of colostrum and nipple toughening (i.e. rubbing with a towel). Prenatal preparation may prevent sore nipples during breast feeding.

2.3.4 Establishing the Milk Supply

The infant should be put to the breast soon after birth; in the first six hours of life. At this time the sucking behavior is strong; this is a stimulant to milk production. Refer to Appendix I, Physiology of Lactation for more information about the aspects of the breast feeding cycle. Positioning of the infant's mouth on the areola, not only on the nipple, will promote proper sucking. Initial attempts at breast feedings should be long enough for the infant to stimulate the let-down reflex which may take up to three minutes per breast.

During the early weeks it is important to permit feeding on demand, when the infant is hungry, rather than on a schedule. To ensure each breast will be emptied and stimulated equally, the baby should nurse from both at each feeding, starting with the breast last used.

Freedom from fatigue and anxiety are essential to successful lactation because either will reduce the production of milk.

2.3.5 Diet During Lactation

The energy needs of the lactating mother are higher than those during pregnancy. The average milk production of 750 mL per day is equivalent to 2400 kJ (570 kcal). With a weight gain of 10.5 to 12.5 kg during pregnancy, a woman accumulates a reserve of 2 to 4 kg of body fat. These stores will subsidize by one third the energy required to produce milk for approximately three months. To meet the total energy cost of lactation the Recommended Nutrient Intake for Canadians (1982) establishes the daily energy increase for lactation at 1900 kJ (450 kcal). With this guideline the postpartum weight of most lactating women

should return to pre-pregnancy level within three to six months.

The best way to judge if a woman is receiving adequate energy is to assess her weight gain or loss. The normal weight woman should eat to maintain her desired weight once her pre-pregnancy weight is reached. The woman who was underweight prior to pregnancy should eat to achieve and maintain her recommended weight. Lactating women who were overweight before their pregnancy should not attempt a weight reduction diet. However, they might lose excess weight by not supplementing their diet beyond the additional 1900 kJ (450 kcal) allowance.

The additional energy needs for lactation are easily met by a well chosen diet which increases the quantities of foods eaten, particularly from the four food groups of Canada's Food Guide. Similarily, these increases should ensure the provision of additional levels of nutrients, such as protein, vitamins, and minerals required during breast feeding. Vitamin and mineral supplements are not a routine requirement during lactation. They have been found to have little effect on the quality of breast milk. If used they should be prescribed by a physician.

Since water is the major component of breast milk the mother may need to increase her fluid intake to quantities sufficient to satisfy her thirst.

Although an adequate diet for breast feeding is important, a poorly nourished woman will be able to initiate and sustain breast feeding. This is achieved by depleting her body stores of nutrients and/or altering the nutrient content of her breast milk. These are not desirable outcomes.

The significance of the normal alterations in the nutrient composition of breast milk over the span of feeding has not been clarified. Alterations in the maternal diet may influence the volume and some components of breast milk. The volume has been shown to be related to two nutritional factors - energy and fluid intake. A sub-optimal energy intake over a period of days may reduce the volume of milk secreted. Dehydration will reduce the volume.

Although the amount of fat and protein in breast milk remains relatively unaffected by the maternal diet, the fatty acid and the amino acid patterns may be changed. Fatty acid patterns can be modified; for example, a diet high in polyunsaturated fats will increase the polyunsaturated fat content of the milk.

The mineral content of the maternal diet, derived either from direct dietary intake or supplement, appears to have little influence on the levels in breast milk. For example, it has been shown that women consuming diets low in calcium produce milk with an adequate calcium content. This level is maintained by mobilizing maternal skeletal reserves.

The levels of vitamins in breast milk may be related to the maternal diet. The intake of water soluble vitamins appear to be reflected in the milk. However, there is evidence that the intake of the fat soluble vitamins, A,D,E and K, has less effect on secreted levels.

An area of controversy with respect to the nursing mother's diet concerns the effect of her food choices on the infant. The role of the maternal diet in causing infant distress is generally over rated. Usually there is no reason to restrict any food in the mother's diet unless this food has been shown to cause distress in her baby.

Occasionally eating specific foods or large quantities of a food may temporarily distress the baby.

2.3.6 Duration of Lactation

Breast feeding should ideally be continued until the infant is 12 months old. Mothers should be encouraged to continue longer if they desire. The nursing mother who becomes pregnant is at nutritional risk. With individual dietary counselling she can continue to breast feed if her health is good, her diet adequate in nutrients and energy for both pregnancy and lactation, and she is getting enough rest to prevent fatigue.

2.4 Breast Feeding Cautions and Contraindications

There are few situations which require a mother cease nursing her baby. In some instances caution and monitoring by the health professional may be required.

2.4.1 Drugs

It is good practice for the nursing mother to avoid taking any unnecessary drugs during lactation. The mother should be encouraged to advise the doctor that she is breast feeding and wishes to continue. As a rule, breast feeding is contraindicated when the mother is taking substances known to be excreted in human milk at levels which are detrimental to the health of the infant. An alternative medication may be substituted so breast feeding can continue.

The amount of a drug in the milk is a small fraction of the amount circulating in the mother's blood; however, drug toxicity is based on body weight. The newborn infant's ability to tolerate and metabolize drugs changes

rapidly and this can vary within a brief period of time. A key detoxification pathway of the liver, i.e. the combination of potentially harmful materials with glucuronic acid, is generally not fully functioning in an infant under one month of age. The immature enzyme system, combined with the infant's incompletely developed renal function, render him susceptible to the accumulation of toxic levels of drugs. A range of symptoms such as jaundice, irritability, vomiting, and diarrhea may result. Drugs may appear in breast milk in much higher concentrations if the nursing mother has decreased renal function.

The following are some commonly used substances which may be transmitted to the infant through breast feeding.

Alcohol: small amounts may be excreted in breast milk, but have little, if any, effect on the nursing infant. Sedation may be noted if excessive amounts are consumed.

Caffeine: excreted in breast milk at the rate of one percent of that ingested. The concentration in coffee is probably too low to have any pharmacologic effect for the lactating woman or her baby. Therapeutic doses are not significant in affecting the baby.

Vitamins and mineral supplements: no known harmful effects.

Nicotine: excreted in milk. Heavy smoking, 20-30 cigarettes per day, may decrease milk supply and affect the level of circulating vitamin C in the mother's blood. Also, heavy smoking may cause cramping, nausea and vomiting in the infant. Inhaling second-hand smoke increases risks of respiratory infections.

Details of the safety and use of specific drugs during lactation may be found in publication #505, "Breast-feeding and Drugs in Human Milk" by White, G.J., and White, M.K., Veterinary and Human Toxicology which is available for five dollars (1982 price) from La Leche League International Canadian Supply Depot, Box 70, Williamsburg, Ontario, K0C 2H0.

Since information is constantly being updated, the onus is on the health professional to be aware of current developments. Suspected overuse of drugs may be determined in a counselling situation.

2.4.2 Environmental Toxicants

Environmental toxicants such as DDT (Dichloro - diphenyl - trichloroethane), PCB (Polychlorinated biphenols) and PBB (Polybrominated biphenols) are excreted in human milk. In Alberta, with the exception of accidents resulting in high exposure to these toxicants, they do not present any demonstrable danger to the infant. Until further research is done it must be emphasized that the benefits of human milk to the infant far outweigh any potential disadvantages from environmental toxicants.

2.4.3 Illnesses

There are situations in which breast feeding is discouraged or contraindicated. Examples are severe acute illnesses, or chronic debilitating disease in the mother. In these situations the decision to breast feed or not should be made by the mother in consultation with her physician. As long as her nutritional and medical status is closely monitored and her illness is not detrimental to the infant's health, the mother can be supported in her desire to breast feed.

Tuberculosis is no longer regarded as a contraindication to breast feeding. When the mother is receiving adequate treatment and where her general care, including nutrition, is closely supervised breast feeding can be safely practiced.

2.5 Infant Related Concerns

2.5.1 Breast Milk Jaundice Syndrome

Many infants who are breastfed have physiologic jaundice which should not be confused with breast milk jaundice. Some breastfed infants may become jaundiced because of compounds found in breast milk which inhibit the development of enzyme systems necessary for normal bilirubin metabolism in the infant's liver. Infants with this rare form of jaundice have normal growth and otherwise appear well. This condition may be diagnosed by a physician at about four to five days of age. It may necessitate temporarily stopping breast feeding for 24 to 48 hours and feeding the baby a proprietary formula. During this time the mother should express her breasts to maintain a good milk supply. The jaundice should start to recede shortly after the discontinuance of breast feeding and should not reoccur with its resumption.

2.5.2 Refusal to Eat

Sometimes the breast feeding baby will cry after one to two minutes at the breast and then refuse to suck. This is usually seen only in the first ten days or so of life and then resolves itself. Factors to consider are: obstructed breathing; faulty feeding position; inverted nipples; engorged breasts; the mother's concerns about breast pain; and presence of oral thrush (moniliasis).

The management of refusal to breast feed is through treatment of the primary cause, if one can be found. As well, review with the mother the basic techniques of breast feeding.

2.6 Mother Related Concerns

2.6.1 Breast Abscess

A breast abscess is a localized complication of a breast infection. It requires medical intervention, such as antibiotic therapy, which may necessitate a temporary interruption of nursing. If so, the mother should manually express and discard milk from the affected breast. This will facilitate a resumption of breast feeding once the infection has subsided.

2.6.2 Clogged Ducts

Sometimes a milk duct may get clogged. When this happens, milk cannot pass through it and the mother will find a small red, painful lump on the breast. This is best treated by letting the baby nurse at the breast more often and perhaps for a longer than usual time, to promote emptying. The mother may also be advised to take a hot shower and to massage her breast from well behind the plugged area toward the nipple. Then the infant's sucking may relieve the obstruction, allowing milk to flow freely. If the baby does not completely empty the breast, have the mother manually express the remaining milk.

2.6.3 Engorged Breasts

Early in lactation the mother may notice her breasts are engorged, painful, and feel hard and tender. This condition is caused by a combination of swelling of the

tissues, higher blood flow in the breast and the newly formed milk. Engorgement is best prevented by letting the baby feed on demand from birth. Treatment may include manual expression of excess milk. The use of pain relievers should be only on the recommendation of a physician.

2.6.4 Inadequate Milk Supply

Mothers should be reassured that breast milk is watery in appearance and has a bluish tinge. Neither the appearance of the milk nor a reduced breast size indicate an inadequate milk supply. The quality of breast milk can change when the maternal diet is extremely poor, but most commonly the quantity will decrease (see Section 2.3.5 Diet During Lactation).

At other times, excessive activity or stress may cause a temporary reduction in the mother's flow of breast milk. She should be encouraged to rest, and although supplementing the breast milk diet of the infant is not generally recommended, this may be necessary. There is a real danger that excessive supplementation may lead to cessation of lactation. See Appendix I Physiology of Lactation - Inhibition. The milk used to supplement should be a proprietary infant formula and only a small amount should be given, i.e. 30-60 mL (1-2 oz).

Concern for the adequacy of the milk supply may arise when the baby seems to be continually hungry. An important point to communicate to the mother is that her infant may want to nurse more often in order to meet his needs for growth. Infants do not grow on a continuous day to day basis. Rather, they grow in small spurts lasting for a week or so. Nursing more frequently for two or three days will increase the milk supply.

The best guide to the adequacy of milk supply is the baby himself. Six to eight wet diapers per day coupled with an acceptable weight gain is good evidence he is receiving enough milk.

2.6.5 Mastitis

One of the sequelae of a clogged duct is mastitis, a condition which will be accompanied by fever and tender breasts. There is no reason to stop breast feeding. In fact, the treatment of choice in most cases is to promote drainage by increasing the frequency of nursing. Possible additional treatment modes include application of moist heat, forcing fluids, bed rest and analgesics. Occasionally antibiotics are used.

2.6.6 Sore and Fissured Nipples

Poor breast feeding technique may lead to sore nipples. Pain may be prevented by ensuring that the nipple and areola are well placed in the baby's mouth. He should be positioned so he can grasp as much of the areola as possible, with the nipple placed far back on his tongue. Since the pain is worse at the beginning of the feeding and lessens considerably after two or three minutes, the baby should nurse first from the unaffected breast to reduce the strength of sucking on the affected breast.

Fissures usually occur at the base of the nipple. The cause is unknown. Healing is fostered by the application of a mild cream. Additional healing can also be promoted by allowing the nipples to be exposed to air and sunlight. If the fissure persists or gets worse, a possibly allergy to the cream should be considered. Nursing from the affected breast may need to be temporarily stopped. The breast milk may be expressed manually and bottle fed to

the infant until the fissure heals. On resumption, the infant should be nursed for only short periods of time.

2.7 Expression of Breast Milk

There may be time when the lactating mother is unable to feed her infant at the breast for an extended period. This most frequently occurs when a baby is pre-term, and in an intensive care nursery. It is often possible for these mothers to express breast milk for bottle or gavage feeding of their infants, allowing mother and baby to experience at least some of the advantages of breast feeding.

If a mother is unable to feed her child at the breast, she should begin expressing colostrum within 48 hours of delivery. The frequency with which she can express the breast milk will vary, but most mothers initially do so every two to four hours. The mother should wash her hands and breast before expressing milk.

An alternative to hand expression of milk is use of commercial equipment. Breast pumps, either manual or electric, should be used according to manufacturer's directions. Health professionals and members of the La Leche League International, Inc. are valuable resources for the encouragement and education of mothers who are expressing breast milk.

2.8 Storage of Breast Milk

For feeding a very young infant or where the home situation makes it advisable, sterilization of collection equipment and storage containers is suggested. In most other situations washing with hot water and soap, preferably in a dishwasher, is adequate.

The published reports of breast milk leucocytes adhering to glass containers relate to hospital care of preterm infants. In the healthy infant, occasional use of breastmilk which has been stored

in a glass bottle or jar need not be a concern. These immunological properties will continue to be available when breastfeeding occurs.

Storage methods commonly used include pouring the breast milk into either an ice cube tray or into a plastic or glass bottle or jar. Milk should be chilled or frozen immediately after collection. The ice cube tray method provides individual frozen breast milk cubes (approximately 45 mL) which can be transferred to a covered container and collected for small feedings. If using the bottle or jar collection method, additional layers of chilled breast milk may be added to the already frozen milk in the jar, as long as the jar is placed back in the freezer. Space should be left for expansion of milk as it freezes. The resulting product will have a layered effect since there will be some separation of the fat to the surface. Milk taken from the freezer should be thawed under cold, then warmer water, while shaking gently to defrost for feeding. Plastic nurser bags may also be used but do not freeze well. All collections should be dated.

Expressed breast milk may be refrigerated up to 24 hours before use, frozen for two or three weeks in a refrigerator freezer, or for several months in a deep freeze. Once the frozen milk begins to thaw, it should not be refrozen. Breast milk which has been frozen will not retain all of the immune properties, but generally this will not adversely affect the infant.

3. BOTTLE FEEDING

3.1 Practice of Bottle Feeding

There are times when it is impractical or impossible for a mother to breast feed her infant. In these cases the infant will be bottle-fed. The baby should be held during bottle feeding and his position changed from time to time in order to develop a satisfying relationship and to simulate the warmth of breast feeding. A positive aspect of bottle feeding is that other family members, apart from the mother, may participate in the feeding, and this may lead to an enhanced acceptance of the baby.

The establishment of a feeding routine and many of the concerns and problems of bottle feeding are similar to those of breast feeding. All family members or others involved in care should demonstrate a congruent understanding of the feeding needs of the infant. Points to be discussed with those responsible for bottle feeding include formula selection, method of preparation with inherent hazards and, if required, vitamin and mineral supplementation.

For information on nipple selection and use of a pacifier refer to the pamphlet "Baby's Nursing Habits" available from Alberta Social Services and Community Health.

3.2 Proprietary (Commercial) Formulas

In this manual proprietary and commercial formulas are one and the same. The term proprietary is used throughout.

Most proprietary formulas are available as ready-to-serve liquids, concentrated liquids or powders. The ready-to-serve types are more convenient but more expensive. If concentrated liquids or powders are being used, ensure that the formula is being mixed according to the specified directions on the formula cans. Once opened, all liquid formulas should be refrigerated and generally only one day's

supply should be mixed at a time. Opened liquid formulas should not be kept more than two days; they may however, be frozen in the prepared form. Powdered formulas are convenient to keep on hand for the occasional relief bottle for the breastfed infant.

3.2.1 Milk-Based Proprietary Formulas

These are the preferred altenative to breast milk and may be continued through the first year of life. They consist of a combination of cow milk protein (which has been modified for better digestion), a vegetable oil (used to replace the poorly absorbed butter fat of cow milk), and an added carbohydrate, lactose. The energy content is 84 kJ per 28 mL (20 kcal per oz). Most of the proprietary formulas with cow milk base have adequate amounts of vitamins A, B_{12}, C, D, E, folic acid, niacin, pantothenic acid, pyridoxine, riboflavin and thiamin so that infants receiving them do not require vitamin supplementation.

3.2.2 Soy-Based Proprietary Formulas

Soy milk formulas are often used for children with cow milk allergy, lactase deficiency, strict vegetarian parents (refer to Appendix VII-A Types of Vegetarian Diets) and rare disorders such as galactosemia. They consist of soy protein isolate, vegetable oils and carbohydrates such as lactose, sucrose or corn syrup solids. They are usually enriched with vitamins, minerals and necessary amino acids in order to ensure satisfactory growth. Generally, such products are used on the recommendation of the child's physician. It is important that the health professional verify the composition of the product to determine whether the infant should receive a nutrient supplement.

3.2.3 Specialized Proprietary Formulas

Infants with specific problems may require formulas that have the protein, fat or carbohydrate modified separately. They usually contain hydrolyzed casein or amino acids as the protein source, medium chain triglycerides or vegetable oils as the fat source, and glucose, corn syrup solids or other carbohydrates. Special formulas with different energy values are also available.

Generally, the specialized proprietary formulas are used in cases of disorders of digestion, absorption or metabolism and should only be used on a physician's recommendation.

Such products may not be adequate in all nutrients so a supplement may be necessary.

3.3 Home Prepared Formulas

Home prepared formulas do not match breast milk or proprietary formulas in meeting the nutritional needs of the infant. Infants who do not receive the preferred feedings of breast milk or proprietary formulas may be given formulas prepared from evaporated whole cow milk. Supplementation of the home prepared formula to ensure nutritional adequacy may be required.

3.3.1 Evaporated Milk

Evaporated cow milk is available as whole, partially skimmed (2%) or skim. The partially skimmed (2%) or skim milks are not recommended for infants. When evaporated whole milk is used, it should be first be reconstituted with water on a 1:1 ratio to make the concentration similar to whole milk. It is then further diluted, and

sugar or other carbohydrate is added to make the appropriate formula. This is illustrated in Appendix II. Due to the risk of infant botulism, honey and corn syrup are not recommended as a source of carbohydrate in formula. There is little nutritional difference between the several brands of evaporated whole milk which are available. All contain vitamins A, C and D, thus supplementation is not necessary. In addition, the heat processing involved in preparing evaporated milk makes the protein curd more digestible and less likely to cause intestinal blood loss than milk which has not been subjected to the high temperature. Evaporated milk does not require further heat treatment and is therefore the best choice for homemade formulas.

3.3.2 Whole Cow Milk

Fluid whole cow milk is a poor food choice for the infant under six months of age. The protein quantity, type, and the size of the protein curd formed in digestion, are major drawbacks to the use of the unmodified whole cow milk. In addition, cow milk contains only small amounts of poorly available iron.

Prior to use as a food, the size of milk protein curd can be modified by heat treatment, such as in the process of commercial pasteurization; mechanical treatment, such as homogenization; and by chemical treatment such as acidification. The process of pasteurization, whether home or commercial, does not denature the cow milk protein to a degree that is suitable for infant feeding. It has been reported that infants aged less than six months of age fed pasteurized fresh milk experience increased gastrointestinal protein and blood loss. Anemia may be a consequence of feeding young infants fresh pasteurized milk. Two other processes, homogenization and acidification, only minimally denature the protein curd.

Cow milk contains approximately three times the total protein of human milk. The protein constituents are foreign to the human digestive tract and may cause gastrointestinal irritation, intestinal bleeding and can further contribute to iron deficiency. As stated previously, the commercial processing of cow milk, as in proprietary formulas and evaporated milk, denatures the protein making it more acceptable to the young infant's digestive tract.

Although the total fat content of human and whole cow milk is similar, the latter contains fats which are not as well utilized. Differences in enzymes found in the milks account for the lower absorption of butter fat in cow milk.

For the infant aged six months or more, the sample formulas using cow milk summarized in Appendix II may be used when the preferred milks are not available. A pediatric vitamin C supplement of 20 mg daily is required with fresh cow milk formulas until the infant is receiving another source of the vitamin such as two to three ounces of an unsweetened undiluted juice. Since vitamin D is added to all commercially marketed fluid cow milk (36 I.U. per 100 mL), formulas using this form of milk do not require an additional supplement. Use of milk which is pasteurized following directions in Appendix III, Home Pasteurization of Milk, will necessitate another source of this vitamin in the baby's diet. A healthy full term baby does not usually require iron from food or other source before four to six months of age. Supplements should only be given on a doctor's recommendation.

3.3.2 Partially Skimmed (2%) and Skim Cow Milk

Two percent and skim milk are not recommended before 12 months of age. Both of these milks are low in total fat and energy, are deficient in essential fatty acid and their use leads to an increased renal solute load (see Section 4 - Water Balance and Renal Solute Load). To meet his energy requirements, the infant must drink more of these milks. The extra volume of milk required may be difficult for the infant to take, and the amount of protein and minerals ingested will be excessive, further increasing the renal solute load.

3.4 Goat Milk

Goat milk is naturally low in folic acid and it is difficult to supplement an infant's diet with the 40-60 µg required daily. For these reasons the use of this milk should be discouraged until the infant is receiving a variety of solid foods. If it is the milk of choice, the preferred form is canned and fortified with folic acid. However, there is also a need to consider the limited ascorbic acid (vitamin C) content. The reported value for raw goat milk, 15 mg/L, will be significantly lower in the home or commercially pasteurized forms.

Another nutritional limitation regarding growth and development is the low calcium to phosphate ratio. It is even lower than that of cow milk. The use of goat milk with small or immature infants may promote hyperphosphataemic tetany.

3.5 Raw Milk

The use of raw milk as an infant food should be discouraged. The American Academy of Pediatrics issued a policy statement on this topic in 1980. The messages of the statement were the dubious benefits (i.e. greater palatability and unproven nutritional

superiority) and the serious risks (i.e. bacterial enteric disease) inherent in the use of raw milk.

A procedure for home pasteurization is described in Appendix III.

3.6 Bottle Feeding Cautions

3.6.1 Preparation Technique

There is no documented difference in the incidence of illness or infection in infants fed formulas prepared by terminal and aseptic (sterile) methods. The community health professional should advise adherence to the method demonstrated in the hospital or recommended by the doctor when the formula was prescribed. Concerns about housekeeping practices and sanitation should be addressed in a counselling situation which focuses on formula preparation.

Use of disposable plastic nursing systems should follow the directions provided with the bottle liners.

Although, conventionally, formulas are heated prior to feeding baby, evidence of gastrointestinal distress from refrigerator temperature formula is equivocal.

3.6.2 Formula Overconcentration

Sometimes formulas may be overconcentrated and thus contain excess protein, energy and electrolytes. Infants who are fed this incorrectly prepared formula may suffer from severe dehydration, convulsions, renal failure and death (see Section 4 - Water Balance and Renal Solute Load).

Common causes of overconcentration include:

- underdilution of proprietary powdered or liquid concentrate formulas;
- excessive water loss during heating, sterilization and home pasteurization of cow milk;
- inattention to the recommended ratio of cow milk, water and carbohydrate source in home prepared formulas;
- use of undiluted evaporated milk; and
- addition of milk powder to cow milk formula.

3.6.3 Formula Underconcentration

Underconcentrated formulas do not contain adequate amounts of nutrients. Large volumes of these formulas are required to meet nutrient needs. Infants unable to drink sufficient dilute formula fail to thrive. Refer to Section 10.3 - The Underweight Infant.

Common causes of underconcentration include:

- overdilution of proprietary, powdered or liquid concentrate formulas;
- use of overdiluted evaporated milk; and
- false economy - try to "stretch" the proprietary formula cow milk to make it go further.

In both over and under concentration, a possible cause is lack of attention to label instructions. The health professional may need to review label information, formula preparation, and equipment usage with the parents to ensure that they understand how to correctly and safely prepare formula.

3.6.4 Bottle Propping

Propping the feeding bottle on pillows should be discouraged. This practice deprives the infant and the parent of a mutually valuable and rewarding contact. In addition, the flow of milk into the infant's mouth may be too rapid and the infant might choke and aspirate milk. The baby should never be left unattended while feeding from a bottle.

3.6.5 Baby Bottle Mouth (Nursing Bottle Syndrome)

Parents should be advised to avoid putting a baby to bed with a bottle of milk, juice or any sweet liquid. As an infant sucks, liquids are spread over the teeth. Sucking stimulates the flow of saliva, which washes the food or fluid debris from the teeth and promotes the secretion of compounds that buffer the acids in plaque. When children are awake they swallow quickly. When they fall asleep and sucking and salivary flow stops, the sweetened liquids pool around the teeth causing decay.

3.7 Water and Juice

Infants being breastfed or fed a proprietary formula do not generally require additional water. In diarrhea, fever, respiratory illness and hot weather the infant may be offered 60 to 90 mL daily. When there is concern about the bacteriological safety of the water, it should be boiled and cooled before being given to the baby. Water from a well should always be tested for nitrates. For information on nitrates in infancy see Section 13 - Nitrates/ Nitrites.

The use of fruit juices in the diet during early infancy is optional. Breast milk, proprietary formula and evaporated cow milk all contain adequate vitamin C. For the first feedings of juice, introduced at about the same age as cereal, dilution is necessary. The degree and duration of dilution are dependent on the response of the individual infant. An unsweetened vitaminized juice such as apple is recommended for the first feedings. Juices add variety to the expanding taste experience of the second six months of life.

4. WATER BALANCE AND RENAL SOLUTE LOAD

4.1 Water Balance

Water balance refers to the balance between intake and excretion of water. Intake comes from fluids, food or as a product of metabolism. Water loss occurs from the kidneys, skin, lungs and the gastrointestinal tract. Excessive retention may be associated with edema, and excessive loss will lead to dehydration.

Water balance is of concern in infancy. The baby may lose water more rapidly than an older child because of the infant's relatively small amount of body water in relation to the body surface area. Other causes of water losses in the infant are a higher susceptibility to infection with its resultant high fever, rapid respiratory rate and water loss from the gut due to diarrhea. Put more simply, if a 15 kg (33 lb) child were to lose 400 mL (13 oz) of water, this would represent about 2.7 percent of his total body weight. In contrast, if a 4 kg (8.8 lb) infant were to lose 400 mL (13 oz) this would constitute about 10 percent of his total body weight and would represent a very serious loss.

4.2 Renal Solute Load

Important factors governing water balance are the degeree of maturity of the infant's kidneys and the resultant ability to excrete the renal solute load. This refers to the total amount of solutes or waste products which the kidneys must excrete. These solutes are the electrolytes*, metabolic end products such as the nitrogenous compounds resulting from metabolism of protein, and small amounts of other substances. These must be excreted in association with water as urine. An infant's ability to concentrate urine is limited - about half that of an adult.

The more solutes to be excreted, the greater the renal solute load, and the more water required. If there is not enough water with which to excrete the solutes, it may be taken from the extracellular fluid volume and used to form urine. This leads to dehydration of body tissues, a negative water balance, and the retention of potentially toxic products such as sodium and urea.

Normally an infant can manage a high renal solute load, but when losing additional water as in fever, vomiting, and diarrhea, difficulty with water balance may occur. Infants on high solute formulas which create excess renal solute load, tend to develop the symptoms of dehydration, anorexia, lethargy, azotemia, and constipation much more readily than infants on low solute formulas. Dehydration is serious and can be fatal. For this reason infants should always be on a feeding which has a low renal solute load. Breast milk and proprietary formulas have a low renal solute load. On the other hand, volumes of 2% and skim milk formulas in amounts required to

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* Electrolyte is any compound which, when dissolved in water, separates into charged particles (ions) capable of conducting an electric current. Within the body, the electrolytes - sodium, chloride, potassium, calcium, magnesium, phosphate - are essential in the workings of the cells, and in maintaining the fluid balance and a normal acid-base balance.

meet the infant's energy needs present high renal solute loads. This illustrates the importance of recommending milks appropriate for infant feeding. Solids also contribute to the infant's renal solute load. This is an excellent reason to delay the introduction of solids until the infant is four to six months old. Refer to Section 6.1 - Age of Introduction of Solids.

Table 2 shows the relative renal solute load from milks and solids.

Table 2

ESTIMATED RENAL SOLUTE LOAD FROM MILKS AND SOLIDS USED TO FEED INFANTS[1]

Food	Renal Solute Load (Mosmol)	
	per 100 g	per 420 kJ (100 kcal)
Milk		
Human	7.0	10.5
Cow's whole	22.8	34.0
skim	31.1	93.3
Formulas	9.1 - 12.3	13.6 - 18.4
Infant Foods		
Egg Yolk	68.8	19.8
Meats	57.0	48.9
Vegetables plain	11.1	29.1
creamed	10.0	14.7
Fruits	5.0	5.9
Desserts	6.0	6.7

1 Adapted from - Canadian Pediatric Society, Nutrition Committee. Infant Feeding. Canadian Journal of Public Health, 70:376-385, 1979.

5. FEEDING TRANSITIONS

5.1 Transition From Breast to Bottle Feeding

The timing of introduction is reported to affect an infant's receptivity to the bottle. Late introduction of the bottle, i.e. when the infant is about five months old, has been associated with some resistance, whereas introduction of an occasional bottle before the infant is five weeks of age is not. Although not all infants respond in the same way, this information may be useful in individual counselling situations where the mother requires guidance concerning maintenance of breast feeding while working away from home.

When the feeding choice is the replacement of one or more breast feedings with a formula milk, a gradual process of reduced breast feeding must be followed to avoid uncomfortable engorgement and the risk of mastitis.

Expression of breast milk requires guidance from a knowledgable individual. Refer to Section 2.7 - Expression of Breast Milk. As well, the pamphlet "Breast Feeding - It's Your Choice" available from Alberta Social Services and Community Health provides details of the technique of manual expression. A mother who chooses to use only expressed breast milk on her return to work will have to initiate expression and build reserves from small amounts (14 to 28 mL) for several weeks before she returns to work. On return to work she would expect that it will take approximately 15-20 minutes to empty each breast.

5.2 Weaning

In this manual, weaning refers to the cessation of breast or bottle feeding when the infant is capable of taking substantial nourishment from other sources. Generally, weaning should be a gradual but steady process extending over several weeks. It must be remembered

that although weaning deprives an infant of one of his greatest sources of satisfaction, sucking, it is also a step toward his independence. A mother must be patient and give extra love and attention at this time. Feeding difficulties may occur if adults expect the child to master these complex tasks quickly.

Where possible it is best to let the infant wean himself. Sometimes he will give cues - such as sucking for only a minute or two and then arching his back and showing total disinterest in the breast or bottle. The age of self weaning is variable - from about six months to two years.

Occasionally it is necessary to wean the infant from the breast before he is really ready. In such situations, one breast feeding should be omitted at the same time each day and expressed breast milk or proprietary formula, or if desired, after six months of age, whole milk, offered from a bottle or cup instead. The infant should not be forced to drink, but if this milk is refused he should not be allowed to nurse. In a short time the infant will accept the feeding from a cup rather than want to nurse from the breast. Gradually the other breast feedings may be omitted and complete transition will occur.

5.3 Transition to the Cup

As an alternate to breast or bottle feeding and as a developmental challenge the infant should gradually be introduced to fluids from a cup. A training cup with an enclosed spout may be a useful interim beverage container. Milk, formula, juice or water may be offered in small amounts to accustom the older baby to this feeding technique.

The amount offered in a cup should be increased until all milk and other beverages are taken from the cup. Although babies may manage to hold and drink from a cup unaided by age 12 months, full control occurs nearer to the second birthday.

6. SOLIDS

The word "solids" in this manual should be interpreted to mean foods in the infant's diet other than milk, water and juice.

6.1 Age of Introduction of Solids

Milk should be the primary source of energy and nutrients for the infant during the first six months of life. Sometime between four months and one year of age, the infant's diet will be expanded from one of milk to one including solids. These are added to the diet to supplement the nutrients in milk and to meet the increasing nutritional needs of the growing infant. By one year of age the basic meal pattern and food choices of the infant should be similar to those of older children and adults, and should include foods from each of the four food groups in Canada's Food Guide.

Many babies thrive solely on breast milk or formula past six months of age; others require solids earlier than four months. In deciding when to start solids, the individuality of each baby should be recognized. For example, some babies begin life with a higher than average birth weight; some are very active, and some grow more rapidly than others. The growth chart curve is an excellent gauge of the need for expansion of the infant's diet since a decline in velocity may reflect insufficient energy intake. Any or all of these factors may present the need to consider an early introduction of solids.

The ideal age to introduce solids is controversial. The following developmental factors are important considerations.

1. The iron stores of full term healthy infants become depleted four to six months after birth depending on the baby's rate of growth. At this time foods other than milk are needed to provided for growth and to prevent iron deficiency anemia.

2. The normal extrusion reflex of the tongue begins to fade around three months of age, thus reducing the "pushing out" of solids.

3. The secretion of saliva increases at approximately four months of age.

4. There is some evidence that after four to six months of age, the digestive system is more efficient. Before this age, starches and some fats are not well digested. Intestinal irritation may occur when the immature gut is exposed to solid foods.

6.2 Home and Commercially Prepared Baby Foods

Both commercially prepared and home prepared foods are acceptable choices for infants. Advantages and disadvantages can be found for either choice.

Commercially prepared foods are safe, convenient, and are processed to maintain the nutritive value. On the negative side, they may be expensive, or include selections such as soups, desserts, and combination 'dinners' which are low in food value for the money spent. These products may contain unnecessary additions such as starches, sugar or salt.

In order to monitor the infant's intake of sugar per se or one of its various forms, parents should be counselled to check product labels and be reminded that ingredients are listed in decreasing order of content. Any word ending with "OSE" such as sucrose, dextrose, or lactose, as well as these words - 'invert sugar', 'cane sugar', 'syrup', 'honey', 'corn syrup solids' - indicates that a sugar of some type is an ingredient. Even though baby food manufacturers no longer add salt or sugar to all of their products parents should be encouraged to check the product label and choose baby foods without salt or sugar.

On the plus side for home prepared foods is the ability to control ingredients and, for some foods, lower cost. The food used should be fresh or frozen and low in sugar, fat, and salt. Foods with a high salt content such as canned vegetables and cured meat are unsuitable. The addition of salt to homemade infant foods should be discouraged.

The use of fats (butter, margarine, oil, and gravy) and sweeteners (molasses, honey, white and brown sugar) in preparation of foods for the infant is inappropriate. Both may lead to an excess energy intake. Simple carbohydrates, such as sugar or honey, contribute significantly to dental caries and encourage a preference to sweet tasting foods. If foods prepared for family meals are used, the infant's portion should be removed before salt, sugar, other seasonings or thickeners are added.

Infant foods can be prepared with a sieve, grater, food chopper or blender. For information on home preparation refer to the pamphlet, "Preparing Baby's Food" from Alberta Social Services and Community Health.

Food hygiene must be stressed in the home preparation of baby foods. If the health professional determines that home conditions are unsatisfactory, then the use of commercial products should be encouraged.

6.3 Food Safety

The general procedures for handling perishable foods should be observed when infant foods are prepared and stored. Commercial baby foods in cans or jars can be stored in a cool dry place until needed. Once opened, the unused portion remaining from both commercial or home preparation is covered and stored in the refrigerator for no longer than 2-3 days. Longer storage of unused portions is accomplished by freezing; frozen food may be held safely for several months in a deep freeze.

The infant should not be fed directly from the original container if the unused portion is to be saved. Transfer of the feeding spoon from mouth to can or jar carries salivary digestive enzymes which will promote breakdown of the carbohydrate in the remaining food product. For this reason a small portion should be placed in the dish from which the baby is fed.

Raw eggs, and foods containing them, such as eggnog, should not be fed to infants due to the potential hazards of food born infection.

6.4 Guidelines For Introduction of Solids

The introduction of solids in the infant's diet should follow these guidelines:

- introduce new foods one at a time allowing three to four days between each new food;
- choose the least allergenic foods first such as rice cereal, carrots, squash, sweet potatoes, banana, peaches, pears, chicken, lamb or turkey;
- offer early in a feeding when infant is hungry;
- give small amounts initially - e.g. 5 mL (1 tsp); and feed from a small spoon not a bottle;
- encourage the parent to try introducing new foods at a relaxed unhurried time.

6.5 Pattern of Introduction of Solids

The pattern of introduction of solid foods provided in this manual is only one of many which might be suggested. Infant feeding practices, including foods given and age of introduction, may vary from culture to culture and from family to family. Before disapproving a practice which differs from those suggested here, it is important to assess the nutritional value and health consequences of the diet, as well as the growth rate of the infant. If these are acceptable, the practice need not conform to the sequence outlined.

It may be easier to add one or two foods to a given pattern than to radically alter traditional infant feeding modes. Refer to Preface for a chart presenting a suggested infant feeding pattern.

6.5.1 Cereals and Breads

Cereals generally are the first solid food offered to babies. Rice cereal, being least allergenic, often is suggested initially although others could be given.

In Canada, infant cereals are enriched with electrolytically reduced iron which has a high bioavailability. While some quick cooking enriched farinas (Cream of Wheat) do contain added iron, the form used is not as readily available to the baby.

Unsweetened, cooked whole grain cereals may be used after six months of age. Softened ready-to-eat cereals such as shredded wheat or bran flakes may be used when the baby is nine or ten months old. These high fiber varieties contribute more bulk but less iron than infant cereals. For these reasons the use of these cereals should be delayed until other food sources of iron are included in the infant's diet.

Cereals with added sweeteners (rice cereal with honey, mixed cereal with fruit, sugar coated flakes) contain unneeded sugar. Sugars should not be added to cereal at home. High protein cereals are unnecessary and increase the renal solute load. Commercial products which combine formulas, cereal, and perhaps, fruits or vegetables are not recommended because they may precipitate food sensitivities which may be difficult to diagnose. In addition, the use of such products may impede the development of good food habits by masking individual flavours.

In addition to cereals there are a number of other items which can be selected from this food group, many of which can be used as finger or teething foods. The use of whole grain products should be encouraged to enhance their acceptance. When crackers are used, the plain, unsalted variety should be recommended. Because of the higher nutrient content, brown and parboiled (converted) rice are preferable to polished (refined) white rice. The majority of pasta products (spaghetti, noodles, macaroni, etc.) on the market are enriched with thiamin, niacin, riboflavin and iron.

Canned and packaged pasta or rice 'dinners' may be low in protein and high in sodium. Pancakes, waffles and similar items are not recommended for infants because they are cooked in fat and usually served with varying quantities of table fat and sweeteners. Commercial and home prepared baked products, including cookies, contain appreciable amounts of sugar and fat. As a result these items add little to the infant's diet, apart from energy.

6.5.2 Vegetables and Fruits

It is sometimes thought, but has not been verified, that the taste of vegetables may be less acceptable if the infant first becomes acquainted with the sweeter taste of fruits. Nevertheless, it is common practice that a single pureed vegetable be offered before a fruit. Once the first vegetable is well accepted, unsweetened, pureed, mashed, or grated fruits or other vegetables introduced one at a time, may be offered to the infant.

During the latter half of the first year a wider variety of vegetables and fruits with coarser textures should be introduced. Raw fruits and vegetables, either finely grated or blended, may also be given. Chunks of hard raw

fruits and vegetables may be aspirated so are not recommended.

6.5.3 Meat and Meat Alternates

Due to the higher renal solute level these foods produce they should be introduced last, at about six months of age. As with all foods, a single pureed meat should be started first. Coarser textured meat may be offered as the baby matures and develops teeth. Hard cooked egg yolk may also be introduced at about six months of age. Since egg white is a known allergen, it should not be introduced until later, about nine to twelve months of age.

The introduction of other foods from this food group, including vegetable protein sources as meat alternates, is discussed in Section 11.5 - Introduction of Vegetarian Alternates as Solids.

Commerical combination dinners are mixtures of meat, vegetables, egg, cereal, pasta, and/or milk products which offer no advantage over the separate foods.

Home prepared soups, stews, or casseroles when included in the diet of the older baby, should contain a meat or a meat alternate and vegetables in amounts similar to his usual portion. The parent should be reminded to remove the infant's serving before seasonings, including salt, and thickeners are added.

6.5.4 Milk Products

During the latter part of the infant's first year, the daily milk intake decreases due to the increasing intake of solids. At this time too, other milk products may contribute to the recommended daily intake of 600 mL (20

oz). Overemphasis on milk or milk products could lead to the exclusion of other foods, dietary imbalance and milk induced iron deficiency anemia.

Plain yogurt may be given to the infant. It can be mixed with other foods, such as unsweetened fruit. Natural firm or curd cheeses are preferable to the processed and flavored, spread or squeeze type products. Ice cream, ice milk, sherbert, and frozen yogurt desserts are generally high in sugar, and are not recommended during the first year of life.

6.6 Amount of Food

At present, precise information is lacking on how much food babies need or eat at various stages of growth. Any information available which states amounts of solids for various age levels should be considered only as rough estimates or guidelines. For the healthy infant, his appetite is the best guide as to quantity.

Whether the quantity of milk and solids in the diet is reasonable with respect to the infant's needs is best judged by his growth. The energy needs for a given infant may be estimated by multiplying the weight in kilograms by the recommended energy requirement, as recommended in the Recommended Nutrient Intakes for Canadians (1982) - Appendix IV. This is a useful guide; actual needs will vary.

Occasionally it may be necessary to estimate the energy value of the infant's food intake. Energy values of some infant foods are provided in Appendix V.

6.7 Foods Not Recommended

A number of foods are not recommended for infants because they are high in fat, sugar, or provide little in the way of nutrients. Their use may replace more nutritionally complete foods, and con-

tribute to dental caries or poor food habits. Examples of these foods include:

- candy, sugar coated cereals;
- sugar, honey, molasses, syrup, jam, jelly;
- cake, pastry, pie, doughnuts, cookies;
- fried food, highly seasoned food, gravy, sauce;
- breakfast drinks;
- Kool-aid or similar products which have sugar added;
- alcoholic beverages.

Foods such as popcorn, nuts, and seeds are contraindicated because of the risk of aspiration.

7. FLUORIDE SUPPLEMENTS

The dosage and timing of flouride supplements in infancy is controversial. Most recommendations for fluoride supplements are based on the assumption that early supplementation may have a beneficial effect during a period of active mineralization of bone and teeth, and because starting a regimen early in infancy might provide a basis for continued use. Recent research seems to suggest that fluoride acts most effectively on the surface of the tooth and that its use before the teeth have erupted is of little benefit.

The thrust of this research has led to the following:

1. No fluoride supplementation for infants under the age of 6 months.

2. Fluoride supplements should be used after 6 months on a graded dose depending on the concentration of fluoride in the water supply.

These recommendations apply to both breast and bottle fed infants. In the near future virtually all proprietary formulas sold in Canada will be made with deionized water, which contains no fluoride. This should eliminate any concerns currently held regarding the variable amounts of fluoride presently in infant formulas.

The decision as to the dosage used is the responsibility of the attending physician or dentist. As a general rule it is recommended that fluoride be given only as fluoride drops and not as part of a general vitamin preparation. This should tend to reduce the possibility of the infant receiving an overdose of fluoride. Because of the possibility of the development of fluorosis, the local health unit should be contacted if the fluoride level in the local water supply is greater than 2.5 parts per million.

8. IRON

8.1 Factors Influencing Neonatal Iron Levels

Several factors may act separately or in combination to affect the newborn infant's iron supply.

8.1.1 Cord Clamping at Birth

The position of the newborn infant and the timing of the cord have long been known to influence the newborn's blood volume. It is suggested that this may be the sole factor influencing infant iron stores. Holding the infant 40 centimeters below the birth canal for 30 seconds will result in the transfer of about 75 mL of blood into the infant from placenta and cord. The iron content of this volume of blood amounts to about 40 mg or 16% of the total iron content of a newborn infant.

From this standpoint it would be useful to be aware of the local obstetric practice with regard to the clamping of the cord.

8.1.2 Maternal Iron Status

It has been considered that maternal iron insufficiency induces iron deficiency in the fetus and newborn infant. However, a recent research report failed to show any difference in the haemoglobin concentration or the serum iron level at birth in infants whose mothers were iron deficient, normal or iron over-loaded. In addition, there was no difference in the iron concentration of breast milk in the three categories of mothers. This evidence supports the view that transfer of iron across the placenta is independent of the mother's iron status.

Pending additional studies regarding the influence of maternal anaemia on the iron status of the newborn infant, it is recommended that pregnant women be encouraged to consume diets rich in iron and that the iron status of the mother during pregnancy be reviewed when advising on the iron nutrition of the infant.

8.1.3 Gestation of the Infant

The iron content of the fetus increases most significantly during the last trimester, paralleling the rapid increase in body size. Thus, prematurely born infants are deprived of iron stores normally acquired during the last weeks of pregnancy.

The infant weighing less than 2500 g should receive iron supplementation under medical supervision. (2-4 mg/kg/day depending on the infant's weight.)

8.2 Infant Iron Stores

At birth an infant generally has a supply of iron amounting to about 75 mg per kg of body weight. This endowment is sufficient to meet the estimated needs for erythropoiesis during the first four to six months.

The breastfed infant appears able to maintain iron balance for as long as 12 months, however, current recommendations advise the introduction of an additional source of iron by six months of age.

Infants not breastfed should be receiving a source of iron by three to four months of age.

8.3 Infant Grouth

While full-term infants have varying growth rates which might be expected to place the fast growing infant at higher risk of iron deficiency anaemia, this is not apparent in clinical practice. Healthy infants appear able to compensate for the increased need through highly effective iron absorption.

8.4 Bio-availability of Iron From Common Sources

8.4.1 Breast Milk

Despite the low concentration of iron in breast milk (0.3 mg/L), it is well utilized, with an estimated absorption of 50%. Consequently breast fed infants rarely develop clinical iron deficiency anaemia.

Breast milk is considered an adequate dietary source of iron for the full-term infant until six months of age.

For the exclusively breastfed infant, it has been suggested that fruits and vegetables be introduced in the second six months of life. This recommendation is based on reports that such foods appear to have an inhibiting effect on the absorption of the iron in breast milk.

8.4.2 Cow Milk Based Formulas

Cow milk based proprietary formulas contain about 0.3 mg iron per 100 kcal. It is estimated that only about 10% of this can be absorbed.

Evaporated milk based formulas are also a poor source of iron which is not well absorbed by the infant's gastro-intestinal system.

The Canadian Pediatric Society therefore recommends that formula fed full-term infants be given supplemental iron by the third or fourth month of life. This may be supplied by use of an iron-fortified infant formula (approximately 2 mg/100 kcal, or an iron-fortified infant cereal (approximately 9 mg/28 g).

In a counselling situation the health professional should reinforce the fact that fresh cow milk causes occult blood loss which can lead to clinical iron deficiency anaemia. Whole cow milk should not be used before six to nine months of life.

8.4.3 Iron Fortified Cereals

All Canadian infant cereals are fortified with iron which has been electrolytically treated to reduce particle size and increase absorption. This makes them an appropriate food to introduce as iron stores are diminishing. Infant cereal has been shown to be effective in preventing iron deficiency anaemia when used from six until 24 months of age. An intake of 28 g, 30 mL or 11 tablespoons will provide approximately 10 mg of bio-available iron.

8.4.4 Iron Medication

Iron drops (ferrous sulphate) may be prescribed by the infant's physician. These are well absorbed and may be used as an alternative source of iron in a dose of 1 mg/kg per day. There is little evidence that oral iron causes gastrointestinal upsets in infants; however, temporary brown staining of teeth may occur.

9. FEEDING PROBLEMS

The majority of the frequently reported infant feeding problems can be solved or prevented by communication between a knowledgeable health professional and the parent or caregiver. Some common concerns are discussed below.

9.1 Colic

The infant with this ill-defined condition typically refuses to settle after his late afternoon or evening feeding, although the symptoms may occur at any time of the day. The baby may have bouts of crying with the knees drawn up or the back arched. These signs are usually accompanied by large amounts of gas. The condition usually starts within a week or two of birth but rarely lasts beyond three months of age.

Studies of infants with colic have failed to show a definitive relationship between the syndrome and prenatal history, birth weight, sex, pattern of bowel movements or weight gain. There are no specific or universal treatments for this time-limited condition. Change of the infant's formula rarely resolves the colic symptoms. Frequent changes in formula should be discouraged since such changes in themselves may be distressing to the infant's gastrointestinal system.

Recently there have been individual case reports which suggest that infants of an early age, three months or less, may exhibit colic symptoms when breastfed by a mother consuming cow milk or cow milk products. These reports are tentative in their suggestion that macromolecular protein substances originating in the cow milk or milk products enter the mother's breast milk. It is proposed that these molecules may precipitate a colic response in the sensitive young infant. There also have been research reports which do not reinforce this theory. Until more evidence is available, all attempts at maternal dietary eliminations to reduce the infant's

colic symptoms should be closely supervised to ensure nutritional adequacy of the mother's diet pattern. Maternal dietary manipulation is not recommended as a general practice for the treatment of colic.

9.2 Constipation

True constipation occurs in infancy when the stool is hard, infrequent and difficult to pass. Parents should be cautioned against home treatment with cathartics, suppositories, or enemas.

Breastfed infants rarely have true constipation. Some will not have a bowel movement for four or five days or even longer. When the infant does have one, the stool is soft and normal for the infant. These infrequent stool patterns do not require any therapy but parental reassurance may be necessary.

If constipation does occur in formula fed babies, a cause to suspect is inaccurate preparation such that the formula is overconcentrated. Constipation occurs among infants not receiving adequate fluids, particularly in the weaning period. Occasionally the very young infant may exhibit constipation if the mother has been on thyroid medications during pregnancy.

In the dietary treatment of constipation, ensure that the infant has an adequate amount of low solute fluid (see Section 4 - Water Balance and Renal Solute Load) such as water or juice. One half ounce of prune juice mixed with an equal amount of water is generally an effective and safe laxative for young babies. For the older child already on a semisolid diet, encourage the feeding of those foods which tend to have a laxative quality such as pureed prunes, other fruits or vegetables. If consitipation persists, the baby should be seen by a physician since there are organic causes of constipation which require specific therapy.

9.3 Diarrhea - Loose Stools

True diarrhea is characterized by frequent passage of loose, watery and unformed stools. It may be functional or organic in nature and may be due to a number of causes.

Food related diarrhea is more common in bottle-fed than in breastfed infants. In the former, the diarrhea may be due to such things as unsafe water or milk supply, unsanitary formula preparation or storage, contamination from other foods or the environment.

While breast feeding elminates many of the risk factors noted above, loose watery stools may occur in these infants. Such stools are a normal physiological variant occuring most commonly in the early months of breastfeeding. One reason may be the fact that the mother's milk contains more lactose (milk sugar) than the infant's gut can efficiently digest. The presence of extra lactose in the infant's fecal matter leads to the retention of water in the gut and results in loose stools. The health professional may need to remind the parent that the breastfed infant's stool is usually quite loose and unformed.

There is no established dietary regimen for mild to moderate diarrhea of short duration. The condition leads to impaired intestinal absorption of all nutrients, including water. The major concerns in short term therapy are fluid replacement and a source of energy. Withholding of milk or other food should only be on the advice of a physician. In severe cases electrolyte replacement, particularly sodium and potassium, should be considered. Commercial preparations for such severe cases are available upon a physician's recommendations.

Another reason for loose stools may be that the breastfeeding mother has eaten some food which causes loose stools and gas in the infant. What appears to occur is that the mother may have eaten foods, components of which are excreted in her milk and cause allergic-type

symptoms or a sensitivity response in her child. This is particular to each mother and baby and no specific foods are at fault in all cases. The problem is resolved when the mother stops eating the offending food. Providing the infant is growing well, loose stools are not a cause for concern unless accompanied by a change in the infant's condition such as vomiting or fever.

9.4 Undigested Food in Stools

Undigested food in stools is commonly observed by a parent. It is related to the normal inability of the infant or young child to digest certain foods, notably vegetable fiber. Often parents require reassurance about this normal physiological limitation of the maturing baby.

9.5 Vomiting and Regurgitation

It is important to differentiate between vomiting and regurgitation. Vomiting is forceful, involves larger amounts and is usually associated with other manifestations of illness; the infant should be seen by a physician. Regurgitation is the spitting up of a small amount of food and is not unusual for young infants. Common causes are: overly vigorous burping, overfeeding, bottle propping, and sometimes, too much movement right after feeding. Most infants who regurgitate will have a normal growth pattern, and will not appear hungry.

9.6 Food Sensitivity and Allergy

An infant may show sensitivity to a food. This may manifest itself in many ways but commonly as diarrhea, dermatitis, recurring upper respiratory tract infections and wheezing. These symptoms are not specific to food sensitivity and their significance to true allergy to food items should be confirmed by appropriate immunological testing wherever possible. This is of particular importance where allergy to a major nutrient such as cow milk is concerned. Common

foods with an allergic potential are cow milk, eggs, peanuts, citrus fruits, wheat, oats, rye, barley, tomato, and some meats such as pork and beef.

Breast milk is the optimum first food for the infant with a familial history of food allergy. In order to minimize any sensitization, the breast feeding mother should be encouraged to vary her diet and to avoid a large intake of any one food. Soy formula preparations are the second choice to breast milk in the baby at risk of allergy, although sensitivity to soy protein may occur. Ideally, the infant who exhibits sensitivity should be breastfed for the first year of life. Alternatively, he should be fed soy or other hypo-allergenic type of formula. A suitable milk will suffice as nourishment for the first four to six months.

With allergy prone infants, as well as those with a familial tendency to sensitivity, solids of low allergenic potential should be introduced one at a time over a period of several weeks. Such foods include rice cereal, these vegetables and fruits -- carrots, squash, sweet potato, banana, pears, peaches, and these meats -- chicken, lamb, turkey.

9.7 Satiety

Sometimes it is hard to know when an infant is full and does not want to eat any more. However, infants do give cues to say they are full. The breastfed infant may refuse to nurse, become fussy, fall asleep, or start to play. The bottle-fed infant may turn his head away. The older infant will start to play with the food or the dishes, want down from the high chair, or otherwise show a complete disinterest in eating. It is important to look for these cues, especially in the young infant, so that overfeeding may be avoided.

10. GROWTH CHARTS

10.1 Use of a Growth Chart

Early in life most babies settle into a pattern of feeding which will promote steady and normal growth as shown by a gain in height and weight. It is important to monitor the growth of the young child because alteration in the rate is often an early sign of inadequate intake or illness.

Growth charts are a technique of monitoring growth, through comparison of weight, height, or head circumference with measurements of reference infants of the same age. The most commonly used data for growth reference purposes are those compiled in 1976 by the National Centre for Health Statistics in the U.S. A modified version of these growth charts is included in Appendix - VI as Figures 1-4.

On the charts the three parameters are marked off in percentiles with the average rate of growth being the 50th. The majority of children (over 97%) will be expected to fall between the 97th and 3rd percentiles.

Generally most children stay near the same percentile during development. However, growth for the individual child does not proceed in a smooth curve as the charts might be interpreted to indicate. Children grow in spurts and their measurements may not adhere to the curves. In addition, parental and sibling height, weight and growth patterns should be considered. Serial measurements at monthly intervals are more valuable than single measurements in determining the significance of such deviations.

Children who were born full term or who are over two years of age and who fall outside the 95th or 5 percentiles should be referred to a physician for complete medical evaluation. A sharp and sustained

deviation from the previous pattern of growth is an indication that the child's nutritional and health status should be evaluated.

10.2 Adjustment for Prematurity

In the case of premature infant, one should consider growth in terms of adjusted age (chronological age in months less months prematurity equals adjusted age in months) or post-conceptional age. Most babies who are premature will be within the normal range for growth if their heights, weights or head circumferences are plotted according to adjusted age. By age two or three years, most of these infants will have caught up, and beyond age two years, correction for adjusted age is not necessary.

Small for gestational age babies constitute a more complex group. A wide range of growth curves may apply to these infants. Surveillance is required by the community health nurse and attending physician.

10.3 The Underweight Infant

The underweight infant refers to one who is "falling off" the growth curve. He may not be below the third percentile but he is not growing at his previous rate. Though uncommon, some infants may be underweight and also short and therefore, have the appropriate weight for their height. These children may be healthy but they could also have a medical problem and should be referred for medical evaluation. The ratio of weight to length which can also be plotted on percentile curves (see Appendix VI, Figures 1,2) is valuable in this regard. Children with endocrine and some genetic causes of poor growth tend to be heavy in relation to their height and fall in the upper percentiles on these curves.

Far more common is the child who fails to thrive or who fails to grow at a previously normal rate. He requires medical evaluation to exclude:

- impaired physical and mental development;
- underlying severe illness of a physical or mental nature;
- parental neglect and abuse.

The underweight child should also be considered to have decreased nutritional reserve in the event of illness and an increased risk of malnutrition.

Some common diet related causes of failure to thrive are:

- overdilution of formula; and
- inadequate dietary intake. (Refer to Appendix V - Energy Values For Typical Baby Foods.)

10.4 Excessive Weight Gain

Excessive weight gain in an infant is determined by comparison with the growth curves of infants of the same age or height. A healthy infant may be following a rapid rate of growth in both weight and height. He may appear heavier and larger than other infants but, when the growth chart is examined, it will be noted that his height and weight are in proportion. This situation is seen in the infant with more than average muscular skeletal mass, and assessment of weight:length on the percentile curves (Appendix VI, Figures 1,2) will show this child to lie well within the 5th - 95th percentiles. This is not obesity.

Sometimes an infant will have a weight in excess of the 95th percentile for both his height and his age. This child is either obese or at risk of developing obesity. This should be confirmed by plotting the weight:length as this will be expected to fall above or close to the 95th percentile. (Appendix VI, Figures 3,4)

Factors contributing to excessive weight gain in infancy include:

- overconcentration of formula;
- excessive amounts of formula being fed;
- early introduction of solids;
- excessive amounts of high caloric density solids;
- cultural and maternal food habits; and
- familial or hereditary tendency to obesity.

The management of infantile obesity is a controversial medical problem. When counselling the parents of the obese infant, consider the following points.

1. The infant should not placed on a weight reducing diet.

2. Encourage the parent not to add any new foods to the infant's diet or to increase the amounts already being fed.

3. Review with the parent some of the cues that infants use to say "I'm full".

4. Have the parent keep a record of the infant's food intake for one week. The information available in Appendix V may be used to assess the infant's daily energy intake. The assistance of a dietitian or nutritionist is helpful in this assessment.

5. Remind the parent that crying does not always mean hunger - sometimes it means thirst, loneliness, or fatigue.

6. Review the daily routine with the parent to determine how much time the infant spends in physical activity and encourage periods of supervised physical activity through play.

11. VEGETARIAN LIFESTYLES

11.1 Introduction

Because of their high nutrition needs, infants are particularly vulnerable to the restrictions imposed by vegetarian diets. Such diets range from those that exclude meat, fish and poultry to those that eliminate all animal products. Refer to Appendix VIIA for a general description of the types of vegetarianism. As well, there can be many variations of the common patterns, the most extreme being the Zen macrobiotic diet. Serious nutritional problems such as scurvy, marasmus and death have been reported for infants placed on this regimen. For this reason, when the parent suggests being a vegetarian, it is very important to ascertain what the infant's diet comprises.

The infant on a vegan diet will have difficulty obtaining adequate amounts of energy and several key nutrients, namely protein, iron, calcium, vitamin D, vitamin B_{12} and riboflavin.

Some studies suggest that the growth of infants and children on very restricted vegetarian diets (i.e. vegan) is most likely to be compromised. Because milk products and eggs can compensate for so many of the nutrient deficiencies encountered in the vegan pattern, the less restrictive lacto-ovo diet should be promoted, particularly where parental commitment to veganism is not strong. Parents may require the expertise of a dietitian or nutritionist to develop adequate food plans for their infant or young child. Nutritional aspects of food patterns which may be of concern in a counselling situation are discussed below.

a) Energy:

An adequate energy intake from a vegetarian diet is difficult to obtain for infants and young children for several reasons. The energy value per gram of food is often lower. To further

compound this problem, the child's gastric capacity may not be able to accommodate the volume of food required to meet energy needs. For example, to obtain even half his daily energy needs, a one year old child would have to consume two and a half cups of cooked rice. Rice alone does not meet his nutritional needs beyond energy. The energy value of the diet may also be reduced by the inferior digestibility of plant proteins. Lastly, the intake of fat, an important energy source, may be less in vegetarian diets than in conventional diets.

b) Protein:

The question of protein adequacy pertains primarily to infants of vegan parents because adequate intakes need not be an issue for those vegetarians who include milk or soy products and/or eggs in their diets.

The nutritional problems encountered with plant protein are related to quality and digestibility. Plant proteins are low in one or more of the essential amino acids. Appropriate combinations of plant proteins need to be eaten at the same meal to ensure adequate quality of protein. Cereal and legume combinations are an excellent example of the system of complementary proteins. Cereals are good sources of methionine, the limiting amino acid in legumes, while legumes are a good source of lysine, the limiting amino acid in cereals. Refer to the chart in Appendix VIIB for other systems of complementary protein.

Digestibility also affects protein adequacy. While plant proteins provide as much or more protein per calorie than animal protein sources, their digestibility is considerably less, reducing the amount of nitrogen absorbed. There are a number of studies showing that plant proteins are poorly utilized by children as evidenced by reduced height and weight

for age. Theoretically the child could consume more protein to make up for the poorer absorption, however, as noted earlier, this may not be possible due to his limited gastric capacity. As well, from a practical point of view, the texture of the many plant proteins is not suitable for the infant.

c) Vitamins:

When milk products are excluded, Vitamin D and riboflavin requirements become difficult to meet. The main dietary sources of Vitamin D are fortified milk and margarine. The majority of riboflavin in the infant's diet is supplied by milk and milk products.

Vitamin B_{12} is found primarily in animal foods. For this reason the potential for Vitamin B_{12} deficiency exists when the diet excludes all animal products. Although adults with adequate stores of B_{12} may exist on vegan diets for years without problems, this may not be true for infants and young children who have not yet built up stores and for women during period of increased nutritional need such as pregnancy and lactation. Vitamin B_{12} deficiency symptoms observed in infants include growth failure, megaloblastic anemia, neurologic anomalies, homocystinuria and methylmalonic aciduria.

Parents following vegan diets should be counselled regarding ways to meet the infant's vitamin requirements.

d) Minerals:

The dietary intake of calcium is greatly reduced by the elimination of milk and milk products and fortified soy products. Although some plant foods, notably green leafy vegetables, legumes and pulses contain appreciable amounts of calcium, the availability of this mineral may be reduced because of the fiber and oxalic acid content.

The intake of iron may be similar for vegetarians and non-vegetarians but the bioavailability may be considerably less for the former group. Meats provide the most absorbable source of iron, heme iron, whereas plant foods contain only nonheme iron, a less available form. When considering iron bioavailability it is important to note that several factors affect the absorption of iron from food; these factors include the presence of heme iron, the combinations of foods eaten together and the iron stores of the individual. Infant cereals provide a dependable source of iron in the infant's diet. Refer to Section 6.5.1 - Cereals and Breads.

The higher fiber intake associated with vegetarian diets may interfere with the absorption of certain minerals. Overuse of high fiber foods is not recommended for infants.

11.2 Breast Feeding

The vegetarian woman should be assessed regarding the adequacy of her diet and advised of the normal dietary guidelines for lactation. Refer to Section 2.3.5 - Diet During Lactation. When the diet is restrictive, notably in the case of vegans, more effort and knowledge are required to ensure nutritional adequacy for both mother and infant. Lactating women may require counselling regarding ways to meet their protein, calcium, iron and Vitamin B_{12} requirements when animal foods have been eliminated. Megaloblastic anemia has been documented in breast fed infants of vegan mothers due to an inadequate dietary intake of Vitamin B_{12} by the mother. Recommendations regarding nutrient supplementation of the breast fed infant should be reviewed with the parent. Refer to Section 2.2.5 - Vitamins.

11.3 Bottle Feeding

For the first six months of life the most appropriate alternatives to breast feeding in a vegetarian lifestyle are either a proprietary

cow milk formula or a proprietary soy based formula. Both types, as discussed in Section 3.2 - Proprietary Formulas, are designed to meet the nutritional needs of infants. Lacto-ovo vegetarians may select any of the standard proprietary formulas. The vegan who wishes to exclude animal products from the infant's diet should be referred to a physician for counselling regarding the selection of a soy based formula.

Infants over six months of age may be given pasteurized whole cow milk or continued on formula. The infants of vegans should be continued on a fortified soy based milk.

Unconventional formulas described in Section 12.1 - Fad Formulas should be discouraged. None of these have been proven superior to the conventional proprietary formulas for infants. Although goat milk may be the preferred choice of some parents, it should be discouraged until the child is consuming a varied diet. Refer to Section 3.4 - Goat Milk.

11.4 Weaning

Refer to Section 5.2 for a detailed discussion of this topic.

11.5 Introduction of Vegetarian Alternates as Solids

Infants of parents adhering to a vegetarian diet should receive solid foods at the same age as the non-vegetarian child. The pattern of introduction of solids is the same and the guidelines regarding texture apply; ie. progress from pureed to table foods. Refer to Section 6 - Solids.

The main difference in the diets of vegetarians will be related to the choices in the meat, fish, poultry and alternate food group and the milk group. In place of meat, fish and poultry, children in vegetarian families should receive pureed plant proteins, mild milk

cheese, tofu and meat analogs (meat-like products made from vegetable protein).

The introduction of nut butters should be delayed because of the possibility of sensitivities. After six months of age, infants on a lacto-ovo vegetarian diet will be able to have hard cooked egg yolk, and at nine to twelve months, the whole egg.

Because the texture of meat alternates may influence the adequacy of intake, it is important that these foods be suitably modified for the infant. For example, legumes and grains including rice, must be well cooked and put through a sieve, blender or baby grinder. Thinning may be necessary to make a suitable consistency. The use of oils to thin pastes for infant feeding is not recommended. Refer to Section 6.2 - Home and Commercially Prepared Baby Foods.

12. FOOD FADS

12.1 Fad Formulas

A variety of preparations, have been promoted as infant formula in the popular literature. They are generally homemade, and concocted from a combination of ingredients such as: coconut milk, powdered almonds, soaked soybeans, Kokoh (a grain based beverage), barley water, fruit juice mixtures. These beverages do not meet the nutritional needs of infants and are very susceptible to errors in formulation. Thus the infant is at risk of receiving inadequate or excessive amounts of specific nutrients. In fact, rickets, growth failure and potassium depletion have been linked to the use of inappropriate milk substitutes. The use of such "formulas" for infant feeding should be actively discouraged by the health professional.

12.2 Fad Practices

Health professionals should be on the alert for the use of unconventional beverages, foods and supplements in the infant's diet. Some of the practices may have serious health implications for the infant. Herbal teas are sometimes used to treat minor problems. Toxic dose related effects, ranging from diarrhea to death in infants, have been reported for these products. Such products should be used cautiously, particularly since they offer no nutritional advantage to the infant's diet.

Despite the lack of scientific support, supplements are often included in the infant's diet for various reasons. The literature contains numerous reports documenting the toxic and potentially lethal effects of excess intakes of specific nutrients. For example, overdoses of potassium may lead to hyperkalemia and death.

Misconceptions about processed foods may lead to overly restricted or unbalanced diets. It is important to help the parent put into perspective issues relating to food processing, additives, natural foods, organic foods and health foods and to ensure that the infant's diet is not compromised.

13. NITRATES/NITRITES

Nitrite combines with hemoglobin to form methemoglobin resulting in methemoglobinemia. This is a potentially fatal condition which reduces the blood's ability to carry oxygen and may result in cyanosis and asphyxia. The susceptibility of infants under three months to methemoglobinemia is believed due to the ease with which fetal hemoglobin can be oxidized.

Nitrites may be formed in the body from nitrates in food and privately owned water supplies, e.g. wells, dugouts, etc. The danger to the infant of the nitrates is through conversion to nitrites in the gastrointestinal tract. Two conditions which favor this conversion are the gastric juice with a pH less than four and the presence of nitrate reducing bacteria in the gut. When these conditions are not present, nitrates are metabolized and excreted.

If the infant is to be given water from other than municipally supervised supplies, it should be tested for nitrates. Remind the parent or caregiver that boiling does not remove the nitrates but concentrates the level in the water. Case reports of methemoglobinemia related to water intake document the susceptibility of infants aged less than six months.

Although nitrates are present in some vegetables, such as spinach, beets, and carrots, cases of methemoglobinemia have not been related to use of commercially prepared infant foods and these vegetables only very rarely present a problem in home prepared foods. To minimize risk when preparing infant food at home, fresh, canned or frozen vegetables are suggested rather than long term refrigerated or root cellar storage products. In years past there have been reports of methemoglobinemia in infants aged between six months and one year following ingestion of vegetables stored under such conditions.

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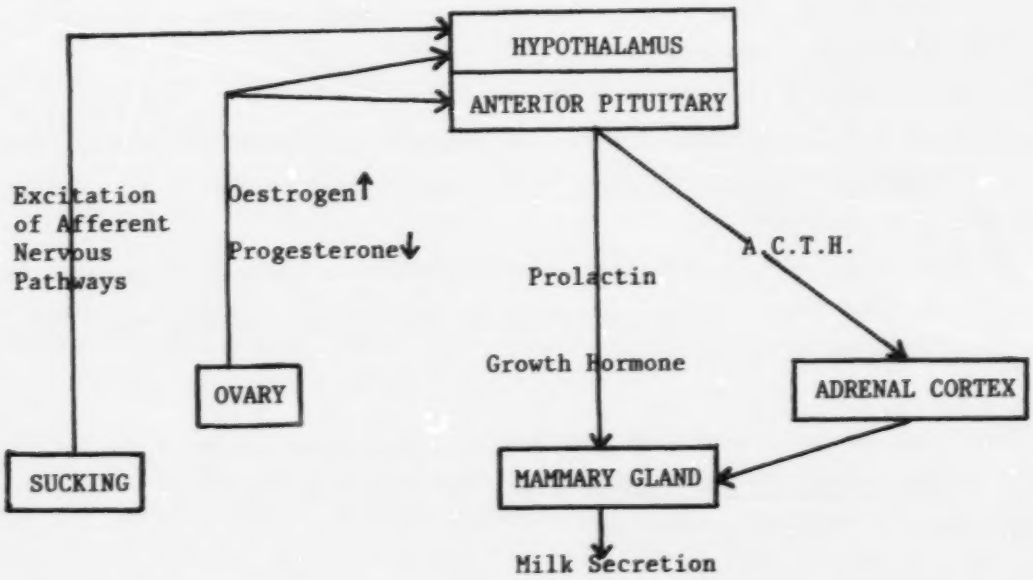
PHYSIOLOGY OF LACTATION

Initiation

The initiation of lactation involves the anterior pituitary hormones - prolactin and growth hormone - which act directly on the mammary gland, while A.C.T.H. acts on the adrenal cortex to increase glucocorticoid production which also induces milk secretion. Ovarian and placental hormones influence the growth of mammary tissue during pregnancy and modify the release of prolactin and A.C.T.H.

Sucking is a further factor, an excitation of the sensory nerve endings in the nipple and areola is transmitted to the hypothalamus, triggering the release of these lactogenic hormones.

The pathway of lactation or milk secretion is illustrated in the following diagram.[1]

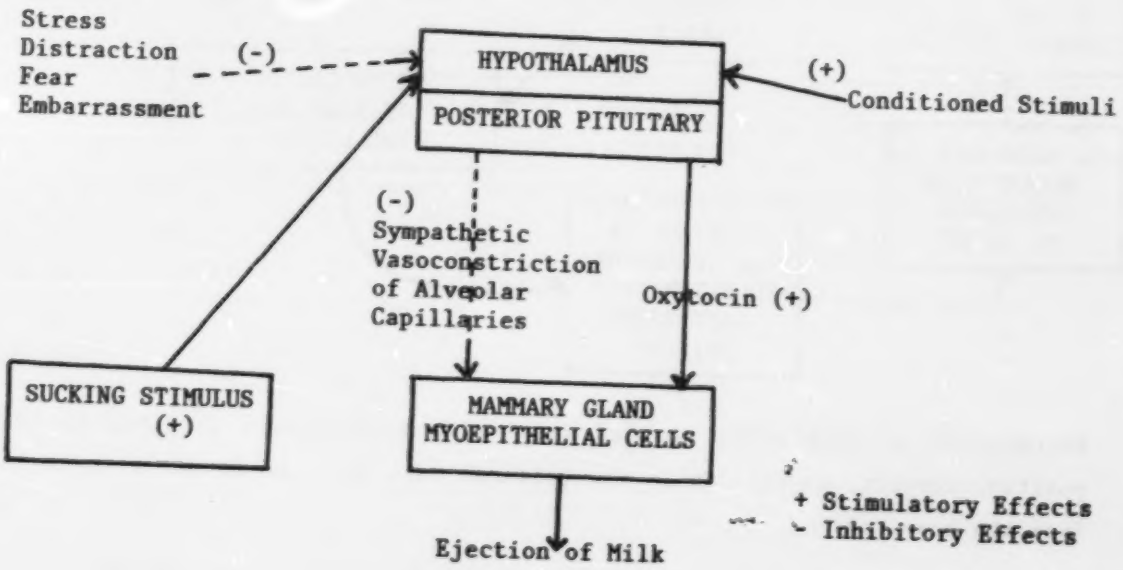


1 Diagram adapted from: International Planned Parenthood Federation Research in Reproduction. Vol. 6, No. 6, Nov., 1974.

Maintenance

Maintenance of lactation is enhanced by the let-down reflex whereby the sucking stimulas excites nervous pathways to the hypothalamus and triggers release of oxytocin from the posterior pituitary. Oxytocin acts on the myoepithelial cells surrounding the secretory alveoli in the mammary gland causing contraction of these cells and expression of milk into ducts and sinuses. This emptying of the alveoli by oxytocin favors further milk secretion as does manual expression. Incomplete emptying of the alveoli reduces further milk secretion.

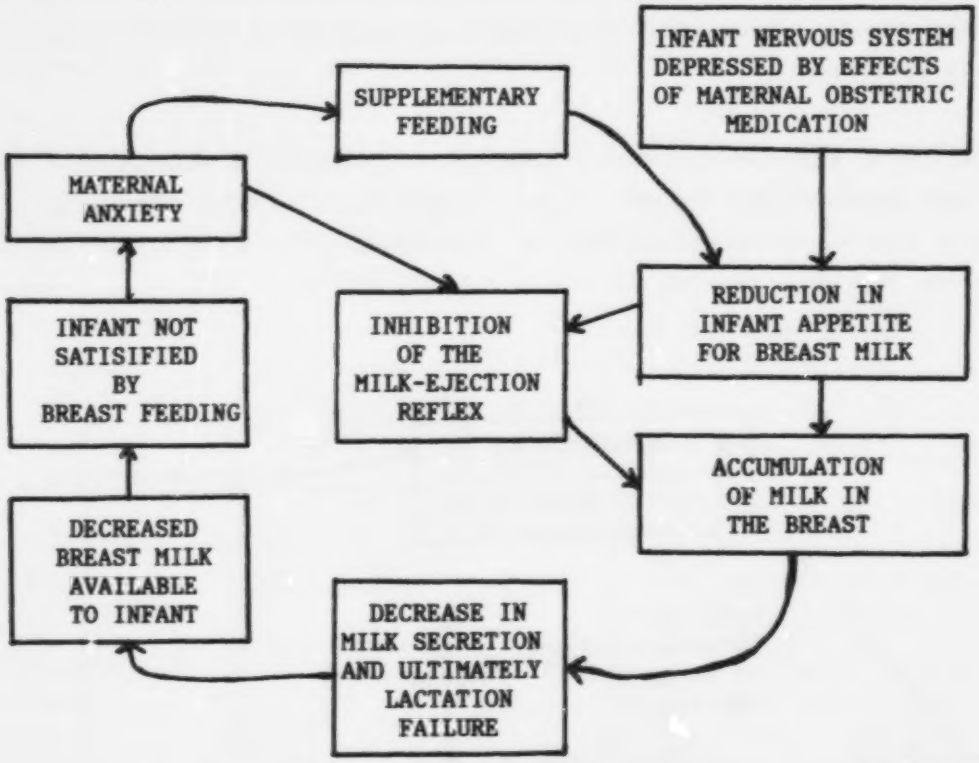
Oxytocin secretion may also occur as a conditioned response to stimuli such as the sight and sound of the infant. Other stimuli have an inhibitory effect; included are stress, distraction, fear or embarrassment. The diagram[1] below summarizes the responses to stimuli.



1 Diagram adapted from: International Planned Parenthood Federation Research In Reproduction. Vol. 6, No. 6, Nov., 1974.

Inhibition

Situations experienced by breastfeeding mothers frequently result in anxiety. The following figure[1] illustrates how this may lead to the cycle: diminished milk secretion ⟶ hungry infant ⟶ increased maternal anxiety ⟶ supplementary feeding ⟶ lactation failure.


INFANT NERVOUS SYSTEM DEPRESSED BY EFFECTS OF MATERNAL OBSTETRIC MEDICATION
SUPPLEMENTARY FEEDING
MATERNAL ANXIETY
INFANT NOT SATISIFIED BY BREAST FEEDING
INHIBITION OF THE MILK-EJECTION REFLEX
REDUCTION IN INFANT APPETITE FOR BREAST MILK
ACCUMULATION OF MILK IN THE BREAST
DECREASED BREAST MILK AVAILABLE TO INFANT
DECREASE IN MILK SECRETION AND ULTIMATELY LACTATION FAILURE

Recognition of this cycle enables the health professional to intervene with positive support, especially on the critical days when the mother returns home from the hospital.

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1 Diagram adapted from: International Planned Parenthood Federation Research In Reproduction. Vol. 6, No. 6, Nov., 1974.

Sample Formulas For One Day's Supply[1]

Weight of baby	2.72 kg 6 lb	4.09 kg 9 lb	5.45 kg 12 lb
Milk, whole evaporated (canned, undiluted)	180 mL (6 oz)	270 mL (9 oz)	360 mL (12 oz)
Water, boiled, cooled	360 mL (12 oz)	450 mL (15 oz)	540 mL (18 oz)
Granulated Sugar	30 mL (2 tbsp)	30 mL (2 tbsp)	30 mL (2 tbsp)
Milk, whole fresh pasteurized	360 mL (12 oz)	540 mL (18 oz)	720 mL (24 oz)
Water, boiled, cooled	180 mL (6 oz)	180 mL (6 oz)	180 mL (6 oz)
Granulated Sugar	30 mL (2 tbsp)	30 mL (2 tbsp)	30 mL (2 tbsp)
Total Volume (approximate)	540 mL (18 oz)	720 mL (24 oz)	900 mL (30 oz)

1 Adapted from Canadian Mother and Child. Chapter 14, "Feeding The Baby", Health and Welfare Canada, Ottawa, 1979, p. 153. Refer to this publication for further information and methods for the preparation of infant formulas.

Home Pasteurization of Milk

Flash Pasteurization

Equipment:
- Double boiler
- Strainer
- Cooking or dairy thermometer
- Spoon
- Bottles with lids

Procedure:

1. Place water in the lower part of the double boiler and bring to a boil.
2. Place the strained milk in the top of the double boiler.
3. Stirring occasionally, heat the milk to a temperature of 77°C (170°F).
4. Remove milk from heat and leave standing for one minute.
5. Pour milk into clean scalded bottles. Cover and immediately store in the refrigerator.

Simmer Method of Pasteurization

Equipment:
- Saucepan with cover
- Strainer
- Spoon
- Bottles with lids

Procedure:

1. Place strained milk in saucepan and heat to simmer - the point where bubbles begin to form, but before it has started to boil.
2. Maintain milk at simmer point for half a minute.
3. Remove from heat.
4. Pour into clean, scalded bottles. Cover and store in the refrigerator.

Recommended Nutrient Intakes for Canadians[1,2]

Age in Months	Amount Per Day			
	0-2	3-5	6-8	9-11
Weight (kg)	4.5	7.0	8.5	9.5
Energy (kcal/kg)	120-100	100-95	95-97	97-99
(MJ/kg)	0.50-0.42	0.42-0.40	0.40-0.41	0.41
Protein (g)	11[3]	14	16	18
Thiamin (mg)	---------- 0.40/1000 kcal ----------			
Niacin (NE)	---------- 7.2/1000 kcal ----------			
Riboflavin (mg)	---------- 0.50/1000 kcal ----------			
Vitamin B_6 (mg)	---------- 0.015/g protein ----------			
Folacin (µg)	50	50	50	55
Vitamin B_{12} (mg)	0.3	0.3	0.3	0.3
Vitamin C (mg)	20	20	20	
Vitamin A (RE)	400	400	400	400
Vitamin D (mg) (I.U.)	10 (400)	10 (400)	10 (400)	10 (400)
Vitamin E (mg)	3	3	3	3
Calcium (mg)	350	350	400	400
Phosphorous (mg)	350	350	400	400
Magnesium (mg)	30	40	45	50
Iodine (mg)	25	35	40	45
Iron (mg)	0.4[3]	5	7	7
Zinc (mg)	2[3]	3	3	3

1 Adapted from Recommended Nutrient Intakes for Canadians, Health and Welfare Canada, Ottawa 1982.

2 Detailed rationale for these levels of daily intakes are found in this reference.

3 Breast milk is assumed to be the source of protein, iron and zinc for this age period.

Energy Values for Typical Baby Foods

Energy requirements in infancy are

0 - 6 months	6 - 12 months
491 kJ per kg	453 kJ per kg
117 kcal per kg	108 kcal per kg

Using the following, it is possible to calculate the approximate energy intake for a diet recall.

FOOD	AMOUNT	ENERGY VALUE (Approx.)
Milk		
Breast milk	30 mL	84 kJ
Formula, proprietary	30 mL	84 kJ
Whole Milk	30 mL	84 kJ
2% Milk	30 mL	63 kJ
Skim Milk	30 mL	46 kJ
Cereals		
Cereals, infant, dry	15 mL	38 kJ
Oatmeal, cooked	15 mL	33 kJ
Bread	1/4 slice	75 kJ
Cracker	1	50 kJ
Fruit		
Juice, unsweetened	30 mL	63 kJ
Strained Fruits	15 mL	59 kJ
Junior Fruits	15 mL	59 kJ
Vegetables		
Strained Vegetables	15 mL	33 kJ
Junior Vegetables	15 mL	33 kJ
Meats		
Strained	15 mL	80 kJ
Junior	15 mL	80 kJ
Eggs		
Egg Yolk	15 mL	147 kJ
Dinners		
Strained or Junior	15 mL	63 kJ
"Meat with Vegetables"	15 mL	46 kJ
"Vegetables with Meat"		
Soups		
Strained	15 mL	46 kJ
Junior	15 mL	46 kJ
Desserts		
Strained	15 mL	70 kJ
Junior	15 mL	70 kJ

Note: 4.2 kJ = 1 kcal.
15 mL = 1 Tbsp
30 mL = 1 oz
250 mL = 1 cup

Growth Charts[1]

Girls - Birth to 36 Months	- Weight	Appendix VI, Figure 1
	- Length	Appendix VI, Figure 1
	- Head Circumference	Appendix VI, Figure 3
	- Weight: Length	Appendix VI, Figure 3
Boys - Birth to 36 Months	- Weight	Appendix VI, Figure 2
	- Length	Appendix VI, Figure 2
	- Head Circumference	Appendix VI, Figure 4
	- Weight: Length	Appendix VI, Figure 4

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1 Adapted from growth charts prepared by Ross Laboratories Division of Abbott Laboratories Ltd., Montreal, 1976.

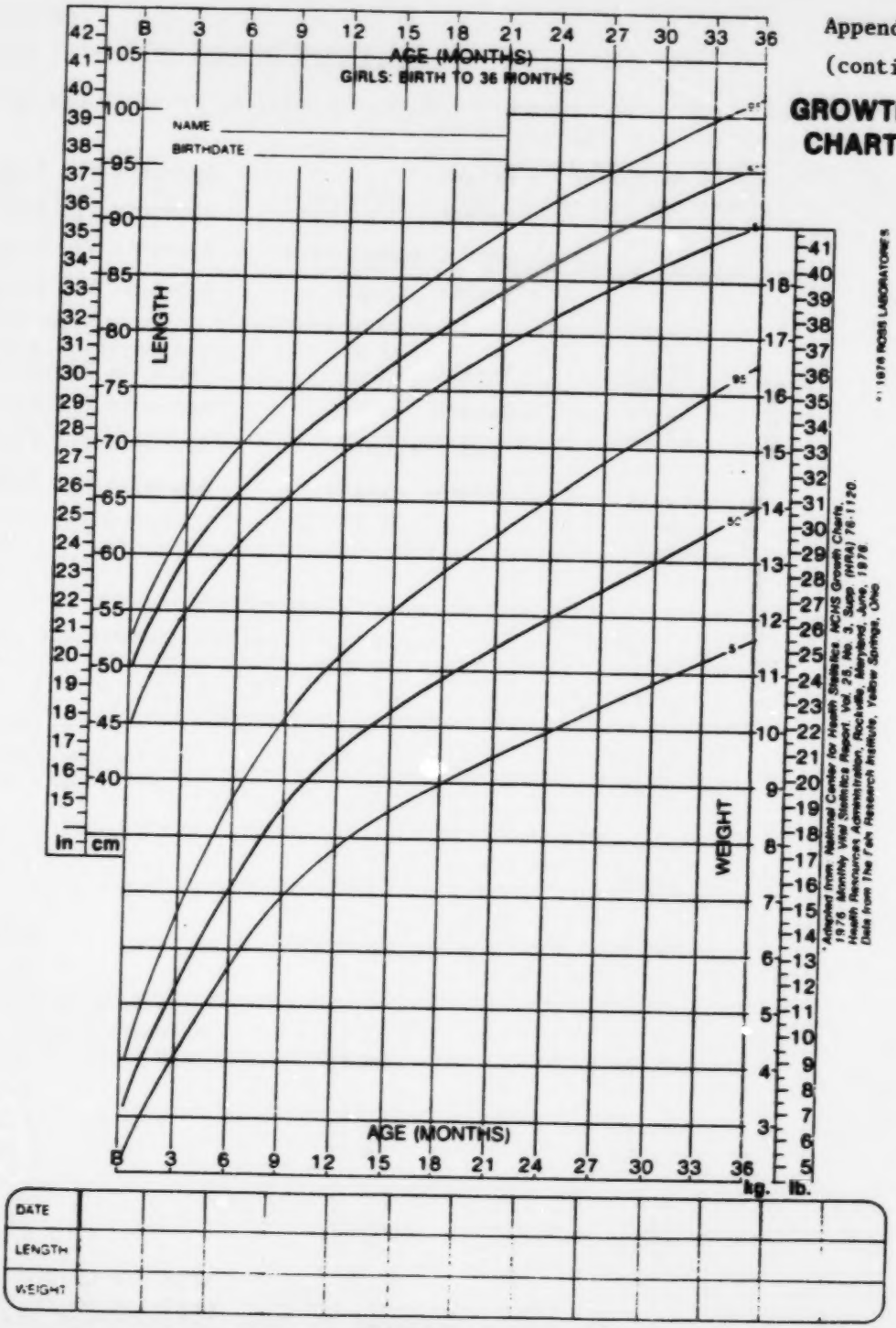

GROWTH CHART
AGE (MONTHS)
GIRLS: BIRTH TO 36 MONTHS
NAME
BIRTHDATE
LENGTH
WEIGHT
in
cm
lb.
kg.
95
50
5
DATE
LENGTH
WEIGHT
© 1976 ROSS LABORATORIES

Figure 1

Appendix VI

(continued)

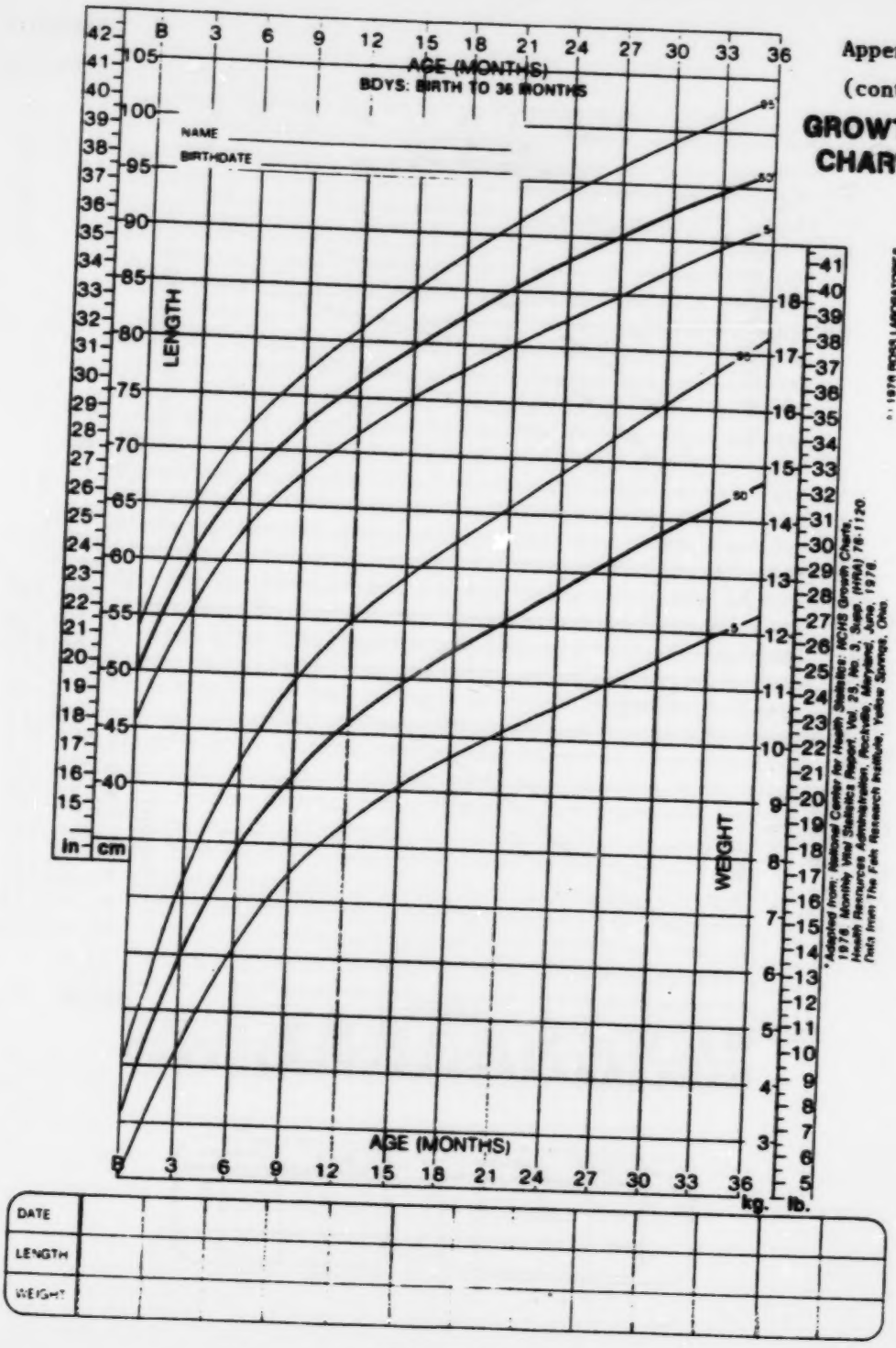
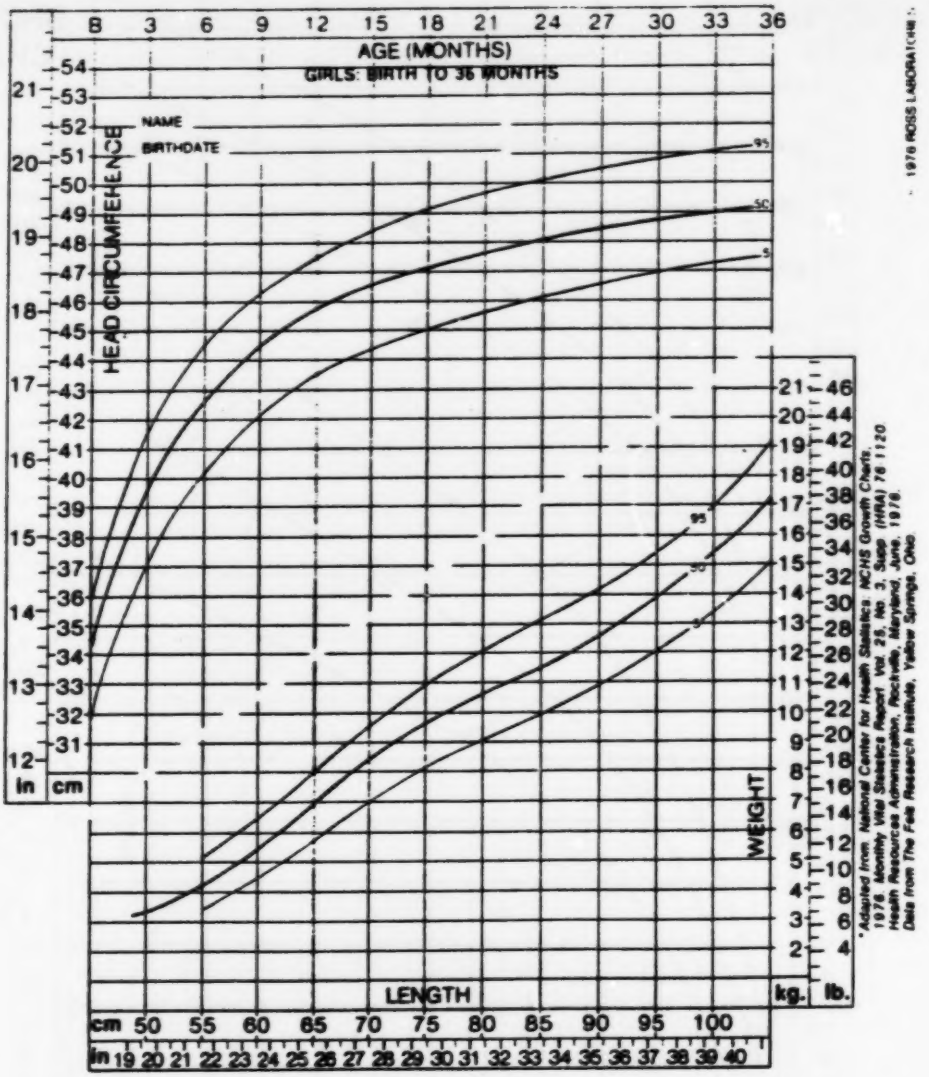


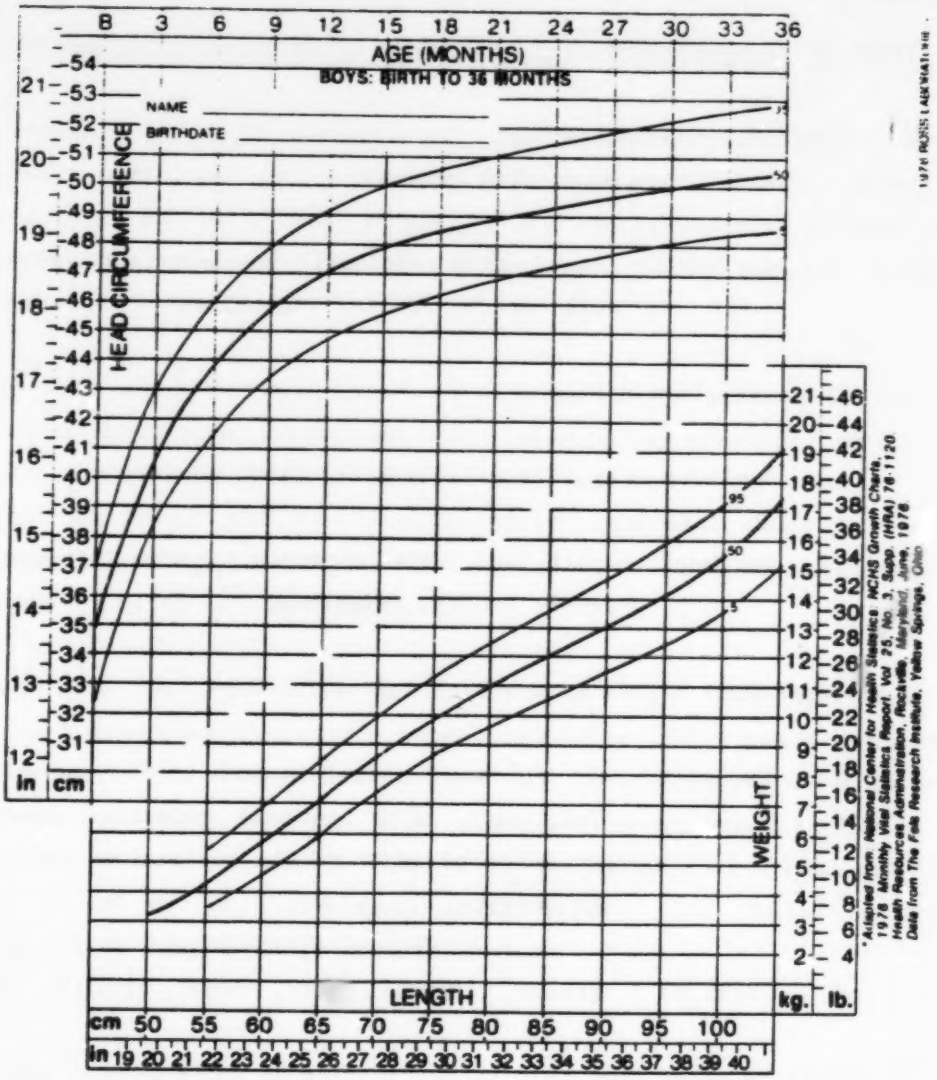
Figure 2



DATE	HEAD CIRC

DATE	HEAD CIRC

Figure 3



DATE	HEAD CIRC

DATE	HEAD CIRC

Figure 4

A. TYPES OF VEGETARIANISM

1. Lacto-Ovo-Vegetarian Diet

   Excludes - meat, fish, poultry

   Includes - eggs, milk and milk products, grains, legumes, nuts, seeds, fruits, vegetables

2. Lacto-Vegetarian Diet

   Excludes - eggs as well as meat, fish, poultry

   Includes - milk and milk products, grains, legumes, nuts, seeds, fruits, vegetables

3. Vegan Diet - This is a strict vegetarian diet.

   Excludes - all foods of animal origin such as meat, poultry, fish, eggs, milk and milk products. However, the exclusion of milk rarely applies to breast feeding for infants.

   Includes - grains, legumes, nuts, seeds, fruits, vegetables

It should be noted that this categorization is not precise. For example, some lacto-ovo-vegetarians may not eat meat, but will eat chicken and fish.

B. COMPLEMENTARY/SUPPLEMENTARY PROTEIN SOURCES[1]

A complete protein contains all the known essential amino acids in amounts sufficient for growth and life maintenance. Plant foods, eaten singly, do not meet this criteria. In a vegetarian diet pattern protein sources must be appropriately combined so that an adequate amino acid pattern is consumed.

One food eaten may supplement or complement the amino acid pattern of another food eaten at the same time. Animal food proteins complement the plant proteins in grains, legumes, nuts and seeds. Proteins in legumes (rich in lysine and low in methionine) complement those in the grain grouping and in the grouping of nuts and seeds (both of which are low in lysine but rich in methionine).

There are some exceptions to the general amino acid pattern in each group. For example, peanuts, which belong to the legumes grouping, are lower in lysine than other legumes. The protein contribution of peanuts is enhanced when consumed with a variety of proteins including other legumes, grains and milk. Generally, the proteins in grains and in nuts and seeds do not complement each other. The following diagram[1] illustrates complementary protein sources.

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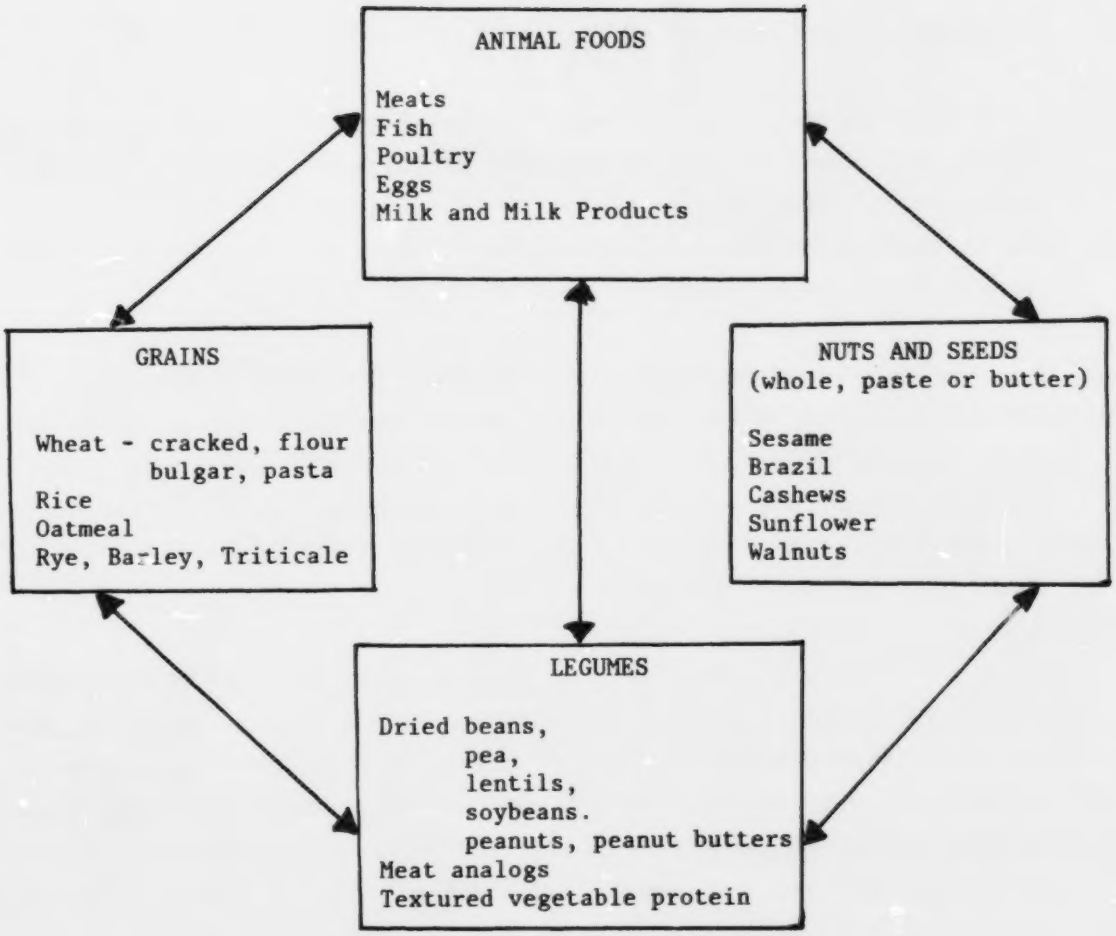
1 Adapted from: Frances Moore Lappe. Diet For A Small Planet, Ballantine Books, Inc., New York, Revised Edition, 1976.


ANIMAL FOODS
Meats
Fish
Poultry
Eggs
Milk and Milk Products
GRAINS
Wheat - cracked, flour
bulgar, pasta
Rice
Oatmeal
Rye, Barley, Triticale
NUTS AND SEEDS
(whole, paste or butter)
Sesame
Brazil
Cashews
Sunflower
Walnuts
LEGUMES
Dried beans,
pea,
lentils,
soybeans.
peanuts, peanut butters
Meat analogs
Textured vegetable protein

HS201D